Gilsonite in Paving Applications

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Historic Applications and Performance of Gilsonite-Modified Asphalt and Hot Mix Asphalt

The history of Gilsonite in hot mix applications is broad and worldwide. Gilsonite's successful uses range from high stress areas in the City of Oslo, Norway; toll booth approaches on the New Jersey Turnpike in the United States; and major city streets and highways in Australia, Singapore, Indonesia, Japan, France and Germany to mention only a few.

In many paving situations it is important to achieve and extend the performance-range of the asphalt by increasing the stability without compromising other properties. Gilsonite has been successfully used in difficult to pave areas that combine very high loads with stop-and-go traffic. The following examples illustrate the breadth and variety of successful Gilsonite uses in hot mix asphalt (HMA).

Oslo, Norway

The city of Oslo, Norway, has been using Gilsonite since the early 1970s for highly stressed areas and for areas with water stripping problems. This use is unusual in that they start with a hard (40-50 penetration) asphalt, and add Gilsonite to produce an extremely hard pavement. These mixes have been found to often double the expected pavement life while giving dramatic visual evidence of improved stripping resistance. Most encouraging is the fact that, even in the severe climate of Oslo, the use of Gilsonite has not created a low temperature cracking problem.

New South Wales, Australia

In New South Wales, Australia, Gilsonite has also been used to reduce severe pavement deformation in a wide variety of high stress traffic situations. Gilsonite is generally applied at a concentration 0.25% by weight of total mix. Inspections after 6, 12, and 24 months have showed a significant reduction in shoving and rutting.

Gilsonite's performance in Australia has been so positive that the Australian Asphalt Pavement Association (AAPA) recommends Gilsonite be used as a modifier for round-abouts to reduce pavement shoving.

Seattle, Washington, U.S.A.

At the Port of Seattle, in the northwestern USA, Gilsonite has been used in an area of extreme distress caused by heavily loaded "top pick" container movers. Gilsonite was added at a concentration equivalent to 8% by weight of binder. A 60/70-pen base was used on this project. The addition was made directly to a pug mill using meltable bags, which easily incorporated into the mix. The cycle time was increased by 15 seconds to ensure complete mixing.

The most stressed section of the Seattle pad was paved with two 2.5” lifts. Installation was smooth and uneventful, the material compacted well, and inspection showed that the aggregate was more thoroughly coated in the pavement containing Gilsonite. Gilsonite modified HMA exhibited superior rut and water resistance after the initial one-year inspection.

New Jersey Turnpike, U.S.A.

The New Jersey Turnpike has been using Gilsonite steadily for over five years. With up to 500,000 vehicles per day, of which 20% are trucks, the NJ Turnpike presents a unique challenge to pavement design. After unsuccessful attempts to use hard asphalts to reduce rutting and shoving, Gilsonite was used as a substitute for 10% of the asphalt. This almost doubled stability, and has resulted in excellent field performance. Rutting and shoving were virtually eliminated without creating a cracking problem. Increased pavement life of at least two years has been recorded.

Chemistry and Physical Properties of Gilsonite and Gilsonite-Modified Asphalt

Gilsonite is made up of very high molecular weight, oligiomeric, polar polynuclear hydrocarbons. Because of the unique polymer-like structure of the Gilsonite asphaltenes it can significantly improve the quality of asphalt binder even at very moderate addition levels. Since Gilsonite is a natural asphalt it readily disperses into asphalt and forms a continuous, completely stable asphalt binder. However, for this to occur it is important that the product be incorporated at temperatures exceeding the Gilsonite softening point by 10° to 20°C (18° to 36°F) and that proper agitation is available to prevent the Gilsonite from settling out before it can be dispersed. For more detail on this important topic please refer to our leaflet "Processing Gilsonite into Asphalt".

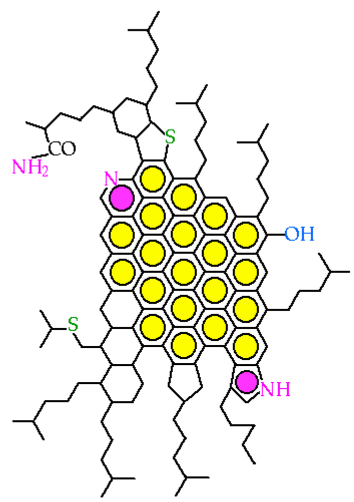

Figure 1: Typical asphaltene structure.

Formulation and Performance Characteristics of Gilsonite- Modified Asphalts

Gilsonite-Modified-Asphalts (GMAs) exhibit generally significantly improved high temperature properties. Because Gilsonite addition changes the oil-to-asphaltene content the low and intermediate temperature properties may potentially be adversely affected. However, when using the modifier at levels ranging between 1 to 4% in conventional asphalts our research indicates that the natural balance of the various asphalt constituents is maintained.

Viscosity and Penetration Graded Asphalts

As previously mentioned Gilsonite can significantly improve the high temperature properties of asphalt binders. Gilsonite increases the Ring & Ball Softening Point, the Absolute Viscosity and reduces the Penetration values of both neat and modified asphalt binders. Consequently, it also increases the high temperature stiffness and reduces the phase angle of the base asphalt.

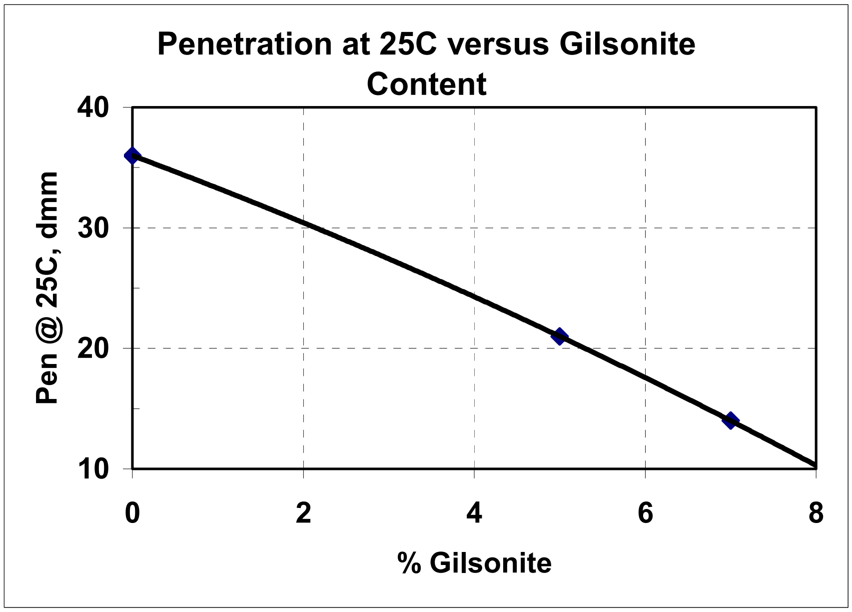

Figure 2: Pen as a function of the Gilsonite concentration.

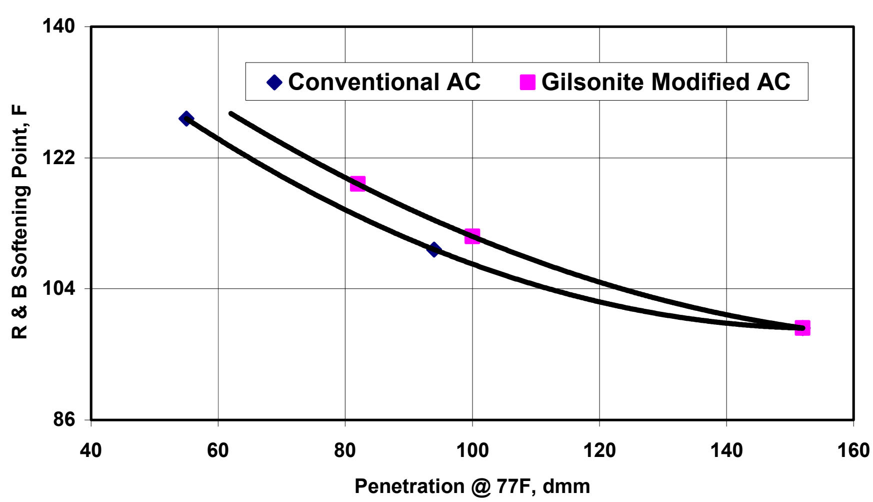

Figure 3: Penetration versus R&B Softening Point for a conventional and Gilsonite blend.

The temperature susceptibility of asphalts can be significantly improved by Gilsonite addition as shown in Figure 3. For example, a blend containing Gilsonite, which has a Penetration of 80 dmm, has the same softening point as a conventional binder with a penetration of 70 dmm.

Gilsonite and Crumb Rubber Modified-Asphalt

Gilsonite has been found to work well with crumb rubber-modified asphalts (CRMAs). The Crumb Rubber (CR) generally imparts excellent medium and low temperature flexibility into the asphalt binder. Hence, CRMA's have been found to exhibit superior durability and cracking resistance even in extreme climatic conditions. These improved properties can be traced back to the enhanced elastic properties of the rubber-modified binders. The excellent low temperature properties come from the aromatic process oils in the CR, which leach out during CRMA production. In addition, the high viscosity of the CRMA allows incorporation of 6 to 12w% binder into the HMA. However, while CR modification and the enhanced binder thickness' dramatically improve pavement durability under heavy loading and/or extreme climatic conditions the binders often exhibit a tendency to fail due to premature rutting and/or bleeding.

As previously mentioned Gilsonite significantly improves the high temperature properties without sacrificing the low temperature properties to the same degree that a stiffer base asphalt would result in. Thus, Gilsonite can be very effectively utilized in mitigating bleeding and rutting versus the non-modified CRMA. Equivalent performance can be achieved at lower CR levels and asphalt contents.

Gilsonite Modification to Create Trinidad Lake Equivalents

Trinidad Lake Asphalt (TLA) has in the past been demonstrated to exhibit superior performance wherever high rut resistance is required. AGC has developed a special Gilsonite grade (GLA II), which provides equivalent performance and is compositionally very similar. The GLA II has a mineral content of 20 to 45% and a R&B softening point of 200 to 230°F.

When compared to a traditional TLA the Gilsonite derived natural asphalt showed equivalent performance as shown in Figure 4 and Figure 5. (The variation in Marshall of the final mix was within the margin of error.)

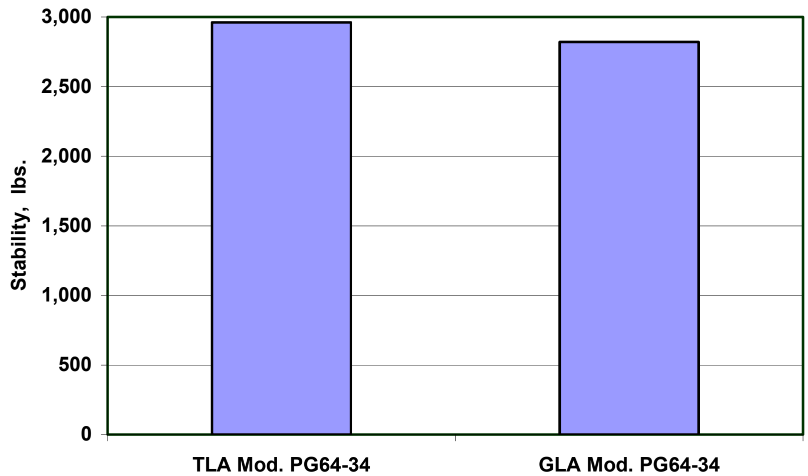

Figure 4: Marshall stability of 20% of GLA versus 20% of TLA in a PG64-34 base AC.

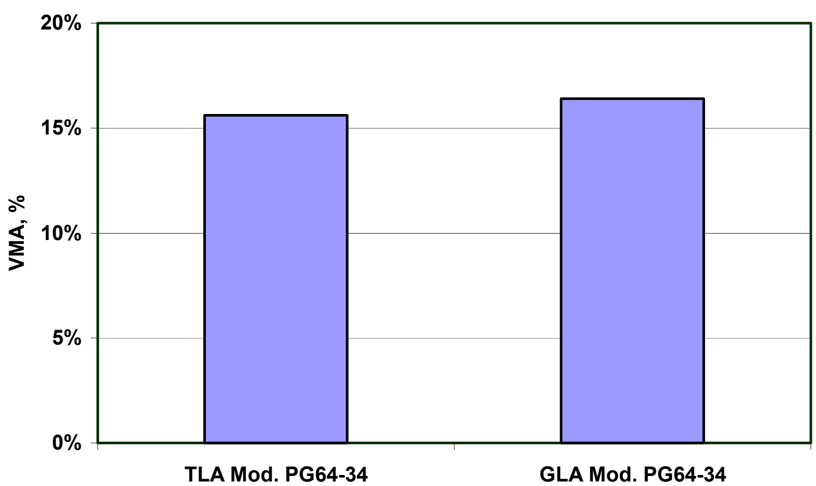

Figure 5: VMA of 20 % of GLA versus 20% of TLA in a PG64-34 base AC.

Improved Marshall Stability

Addition of Gilsonite can dramatically raise the stability of pavement mix. Eight percent Gilsonite (a typical level of addition) will increase Marshall stability by approximately 25% to 40%. This converts a standard pavement into a high performance pavement.

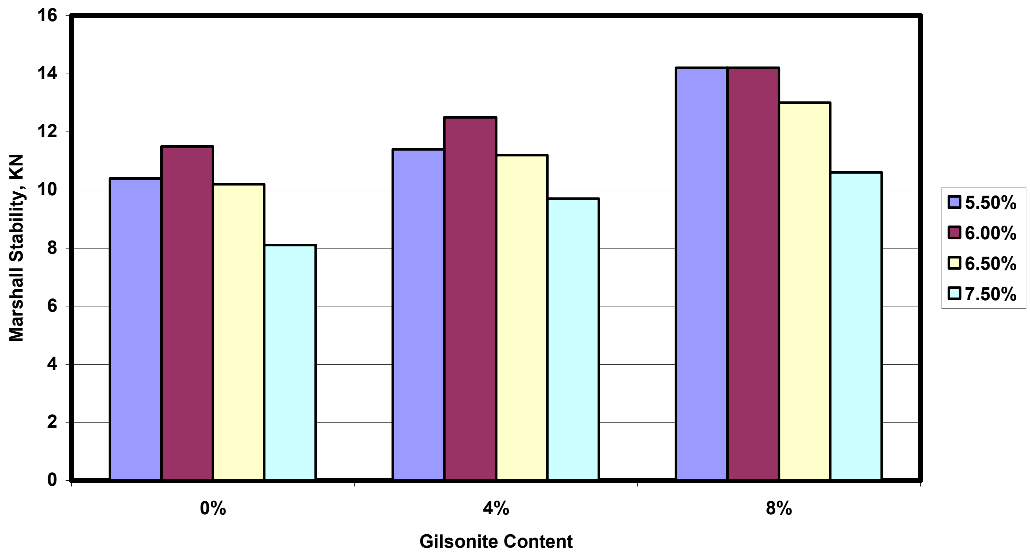

Figure 6: Marshall stability as a function of Gilsonite content .

Water Sensitivity

The use of Gilsonite offers another important benefit--reducing the water sensitivity of the mix. Tests were conducted with a granite gneiss known to be highly water sensitive. Marshall stabilities were tested both with a standard 30 minute immersion in 25ºC water and with a 24 hour water immersion at 60ºC. The data shown below indicates that the mix without Gilsonite never achieves an adequate wet stability level. Gilsonite addition, even at a modest 4% level, produces considerably higher wet stability values.

Marshall Stability (Newtons) After 24-Hour Immersion at 60°C

Bitumen Content	Original Mix	4% Gilsonite	8% Gilsonite
5.5%	Fell Apart	1,990	2,980
6.0%	Fell Apart	3,560	4,980
6.5%	845	4,540	6,690
7.0%	960	5,470	6,440

Dynamic Modulus Studies

Dynamic modulus testing shows that Gilsonite increases the complex moduli of hot mixes in a way that strongly suggests increased fatigue life in commercial practice. These tests evaluate the dynamic modulus of mixes modified with Gilsonite and with Gilsonite/polymer combinations. When used with polymers, Gilsonite appears to selectively increase moduli at high temperatures, which suggests an even higher level of improvement in pavement resistance to rutting and shoving.

Fatigue Studies

The table below shows tests that were conducted at three temperatures and three frequencies, simulating fast-moving, moderate-moving and stop-and-go traffic conditions.

Dynamic Modulus of Gilsonite-Modified Bitumen

Frequency Hz	Temperature °C	Bitumen (70 Pen)	Bitumen + 10% Gilsonite
16	4	13.2	17.1
4	4	11.1	14.6
1	4	8.9	12.9
16	25	4.2	7.4
4	25	3.1	6.1
1	25	2.0	4.6
16	40	1.4	3.4
4	40	0.8	2.5
1	40	0.5	1.6

From these data, an Asphalt Institute computer program was used to calculate estimated fatigue. While these calculations can only be considered a laboratory indicator of actual pavement performance under stressed conditions, the results are sufficiently encouraging to be reported.

The charts shown below demonstrate how the pavement lifetime is forecast to increase approximately 25% due to Gilsonite modification. In commercial experience, the pavement lifetime increase is usually between 100% and 200% when rutting and shoving are the original causes of the pavement failure.

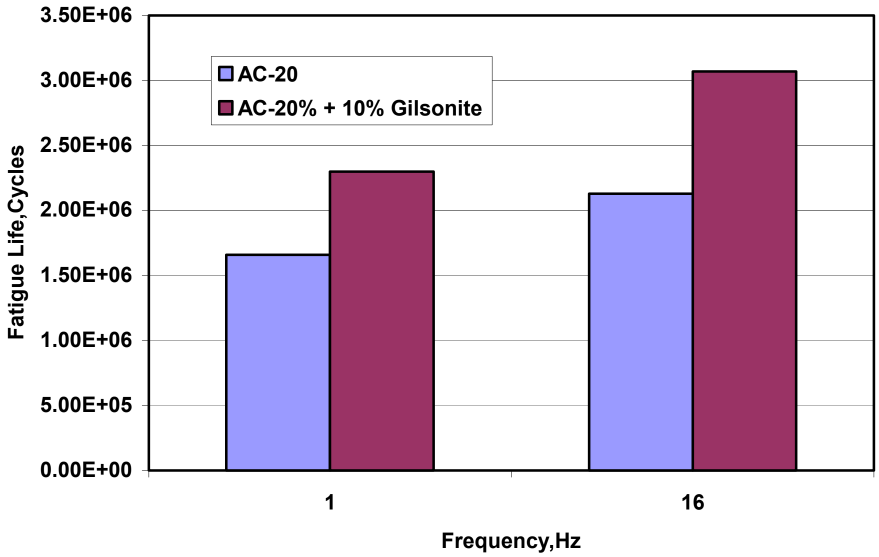

Figure 7: Fatigue life of conventional and Gilsonite-modified asphalt.

Permanent Deformation Studies

Conventional binders were compared with polymer-modified and with systems modified with a combination of polymer and Gilsonite. Our wheel tracking results suggest excellent deformation resistance and superior overall pavement performance. The test conditions included a wheel load of 70 kilograms passing over the sample at 21 rpms for 60 minutes at 60°C.The test was performed on a matrix of binders containing Gilsonite, SBS, EVA and their respective combinations as shown in Table 1. All blends, (except #10) utilized a 70-pen base asphalt. The wheel tracking data shows that best results were obtained with Blend #3 (8% Gilsonite) and Blend # 5 (6% Gilsonite and 2% SBS). The latter even outperformed the blend containing 4% SBS (# 6).

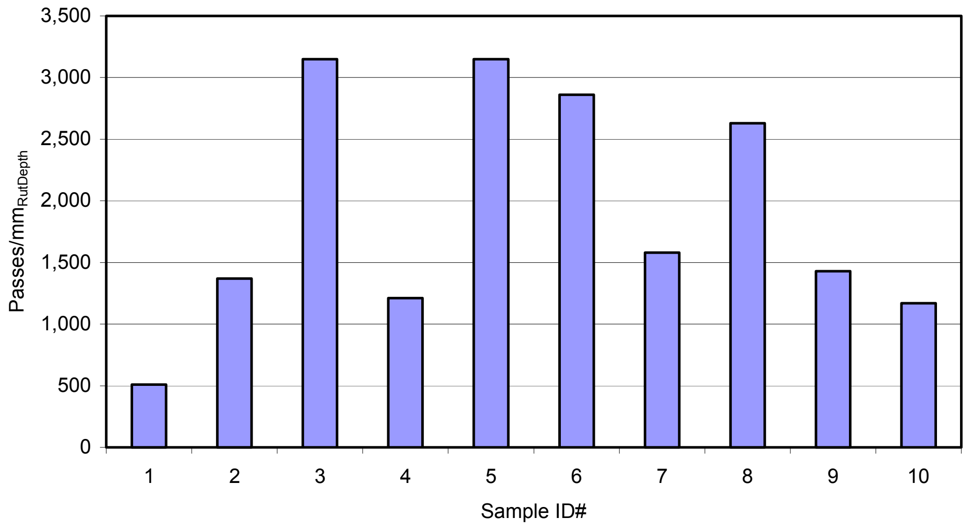

Figure 8: Rut resistance of Gilsonite and polymer-modified asphalts.

	Sample ID#	Base Asphalt	Gilsonite Content, %	Elastomer Content,%	EVA Content,%	Passes/mm Rut Depth	Pen @ 77F,dmm	Viscosity @ 60C, P
70-pen Base	1	100%	0%	0%	0%	510	70	1,440
	2	96%	4%	0%	0%	1,370	43	2,640
	3	92%	8%	0%	0%	3,150	35	4,210
	4	96%	2%	2%	0%	1,210	56	2,960
	5	92%	6%	2%	0%	3,150	38	5,260
	6	96%	0%	4%	0%	2,860	66	5,260
	7	96%	2%	0%	2%	1,580	61	1,870
	8	92%	6%	0%	2%	2,630	43	3,320
	9	96%	0%	0%	4%	1,430	77	1,350
42-pen Base	10	100%	0%	0%	0%	1,170	42	2,920

Table 1: Summary of wheel tracking results.

Gilsonite Grades

Standard Grades

The two standard Gilsonite Grades that are offered are the HMA-MODIFIER and the HMA-BINDER. HMA-MODIFIER is a coarser gradation and is generally used for HMA modification. Conversely, the finer HMA-Binder is primarily used for preparation of GMAs.

High Purity Grades

American Gilsonite Company has developed for the asphalt binder modification market a high purity, low moisture, low ash, extra fine grade, SPG350. This grade is easier to incorporate and is generally less abrasive on processing equipment, as for example, high shear mills.

Laboratory Handling for Preparation of Gilsonite-Modified Asphalt

The asphalt should be heated to a temperature ranging between 190°C (374ºF) to 205°C (401°F). A paddle-mixer is sufficient and no high shear blending is required. We recommend reacting the blend for a minimum of two hours at the above-mentioned temperature. No additional modification steps are generally required.

Processing and Handling of Gilsonite-Modified Hot Mix Asphalt

- Addition is simple, using either meltable bags or a ratable auger system to feed the Gilsonite into the pugmill or the mixing drum at the hot mix plant. This causes minimal disruption to the contractor's operation.
- The Gilsonite is readily combined and completely compatible with the other hot mix components and paving operations are virtually unaffected, i.e., no specialized equipment is required.

Technical Support

For customers experiencing problems or needing support in developing formulations to meet their specific specification requirements we offer the most comprehensive tech support available in the industry. We understand that cookie-cutter approaches generally do not work and that to meet customers needs, custom-tailored approaches are generally required to provide truly cost effective solutions. Thus, our final formulations may include other performance-enhancing materials.

Please do not hesitate and contact us so that we can apply our considerable experience in assisting you in making the next step.