THE UNIVERSITY OF TEXAS AT AUSTIN ✦ COCKRELL SCHOOL OF ENGINEERING

TEXAS PAVEMENT PRESERVATION CENTER

TxDOT Newsletter ISSUE 20 / FALL 2010

Fall 2010 / Issue 20

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Our Mission

The mission of the TPPC, in joint collaboration with the Center for Transportation Research (CTR) of the University of Texas at Austin and the Texas Transportation Institute (TTI) of Texas A&M University, is to promote the use of pavement preservation strategies to provide the highest level of service to the traveling public at the lowest cost. The executive sponsor for the TPPC is the Texas Department of Transportation (TxDOT).

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Past and Upcoming Events

TPPC Microsurfacing Courses

Microsurfacing training courses will be offered by the TPPC. The course is designed for engineers and inspectors and is entitled "Guidelines on the use of Microsurfacing." The course recapitulates the pavement preservation concepts, specifically with reference to microsurfacing. It focuses on proper mix design selection and application of microsurfacing.

Pavement Preservation Strategies with A-R

The Pavement Preservation Strategies with A-R Workshop was held on May 24th at the Center for Transportation Research at the University of Texas, Austin. The workshop included presentations by Dr. Yetkin Yildirim from the Texas Pavement Preservation Center on pavement preservation strategies, Gerald Peterson on TxDOT materials and specification, Douglas Carlson from the Rubber Pavements Association on the advantages of using recycled tire rubber in asphalt, and Maghsoud Tahmoressi from PaveTex Engineering on case studies of AR seal coats and thin overlays.

TPPC Seal Coat Training Courses

Seal Coat training courses will continue to be offered by the TPPC. The course designed for inspectors, entitled "Seal Coat Inspection and Applications," focuses on proper inspection methods and the equipment used during chip seal construction. The other course, "Seal Coat Planning and Design," instructs engineers on planning, designing, and constructing chip seals.

For more information on the Seal Coat courses, please contact Dr. Yetkin Yildirim, P.E. at yetkin@mail.utexas.edu

Asphalt-Rubber and Thick AR Overlays Overview
A presentation by Douglas Carlson

Introduction

Asphalt-rubber has been around for over forty years now after first being developed in the 1960s by a City of Phoenix engineer who was trying to invent a pot-hole patch. The rubber patties that were used to fill potholes ended up outliving the rest of the road. This spurred the question, how can we utilize rubber for the whole roadway rather than merely in potholes? Forty years later that question has found its answer in the form of asphalt-rubber and tire-rubber asphalt.

Creating crumb rubber is the first step to making any A-R. Fiber and fabrics that exist in the tires are removed through a series of blowers at different stages of the rubber shredding process. As these fibers are lighter than the rubber, the blowers can sweep the access material away as the rubber moves through the crumb rubber process. Similarly, any steel that exists in the tires is removed with magnets. In its final form, the crumb rubber particles are smaller than one millimeter in diameter and are free of all non-rubber materials. This rubber is stored in large bulk bags, each weighing about a ton. The rubber remains in this form until it is taken to a hot-plant where it is turned into asphalt-rubber.

In the process, when mixing the crumb rubber with the binder, heat accelerates the absorption of the aromatic oils in the rubber. This heated mixture is constantly agitated to encourage even more release of oils from the rubber and to evenly distribute the rubber aggregate throughout the asphalt binder mixture.

Despite this being a very specialized process, Rubber Pavements Association does not have patents on any of the procedures or products because they want the product and processes to be in the public domain in order to promote competition between suppliers and contractors.

Hot-mix overlays with asphalt-rubber

With most pavement preservation projects, seal coats are used rather than hot-mix overlays because they are cheaper, easier, and often the road isn't in poor enough condition to necessitate an overlay. However, the warm, dry climate in most of Texas allows for a much thinner layer of hot-mix than in other states (approximately ¾ inch). Such a thin layer results in a cheaper cost due to the lowered amount of materials required, making a hot-mix overlay a good option for preventative maintenance on high volume traffic roads in Texas.

Hot-mix overlay projects have become an even more attractive option with the growing use of asphalt rubber (A-R) in gap-grade hot-mix material, where some of the fine aggregate is replaced with ground rubber particles. Such material has been used in the city of Phoenix for almost two decades now and has proved to be very effective. Many of their concrete roadways have received a 3/8 inch A-R hot-mix overlay that contains 20 +/- 3 % ground rubber particles. In this application process, the edges of the road at milled up to three feet on each side so that when the hot-mix is laid down it will fit flush to the edge or curb. A-R hot-mix application differs from the usual hot-mix procedure because the high viscosity of the A-R material results in a quick breaking of the emulsion. Because the pavement will stiffen so quickly, it is key to have the roller running as close as possible behind the paving machine.

Figure 1 Crumb Rubber

Recycling

There are many benefits of using A-R for maintenance projects. The most obvious is the huge amount of rubber waste that is recycled and put to use in the creation of an A-R mixture. In any given city in the country, approximately one scrap tire is created every year for each member of the population. So, for example, in Austin, TX where the population is approximately 760,000, about 760,000 tires will be moved to junk yards or scrap heaps every year. In certain cases, the entirety of the scrap rubber created by a community has been recycled into their road systems. One such example of this is the city of Thousand Oaks, where in the past 17 years, 1,695,000 tires have been recycled and used in the application of A-R hot-mix overlays. This accounts for all of the tires consumed by the population of this city in these past 17 years. So, not only does A-R hot-mix have a superior service life and track record, but it also sends a positive political message and is warmly accepted by the community because of the diversion of waste for recycling.

A-R vs. other kinds of asphalt

While A-R is clearly the more environmentally friendly choice, what is more important to most departments of transportation is performance life and safety. However, A-R hot-mix material out performed five other hot-mix materials in a test of simulated truck traffic. In trials of different asphalt material, the control hot-mix asphalt mixture cracked after 100,000 passes, a terminal blend HMA cracked after 175k passes, the SBS polymer HMA cracked after 275k passes, but A-R HMA did not crack after 300k passes and was estimated to be able to go 1 million passes before cracking.

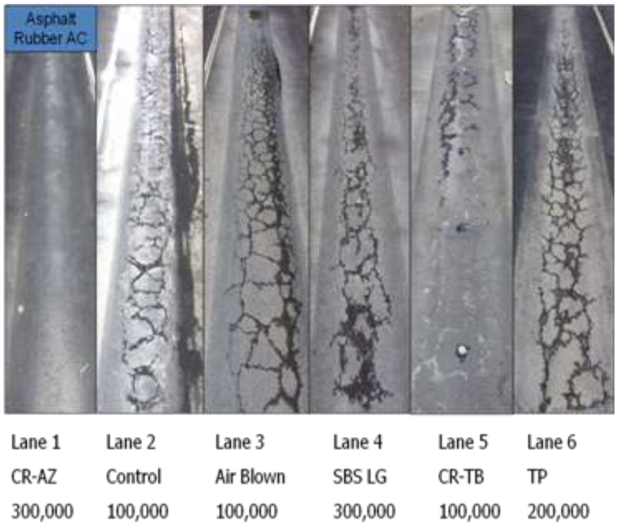

Figure 2 Six Test Sections - Asphalt-Rubber on Left

In all of the other hot-mix materials, cracks form between aggregates in the binder material. With A-R mixtures, the binder material is rubber which does not crack. This results in a far more durable pavement that will have a much greater service life than the other HMA mixtures used in the trial.

More benefits of A-R

A-R is not only an environmentally friendly recycled material with a long service life, but it out performs other HMA mixtures in other areas as well. A-R has the least pavement noise of all HMA alternatives. Pavement noise is greatly due to distress in the pavement, so having less raveling or cracking in the A-R results in less noise on the roadway. What's more, A-R overlays on concrete roads proved to have a higher friction coefficient than the high-friction concrete that was being covered. And if that's not enough, the softening of the road that occurs with the application of A-R material results in an improved, smoother ride and increased fuel efficiency for commuters.

Concrete vs. asphalt

In many hot climates concrete roads are preferred over asphalt because the black asphalt absorbs heat, raising the atmospheric temperature, while the white concrete reflects heat, keeping atmospheric temperatures lower. However, studies on concrete roads with think A-R HMA overlays proved that the thin layer of asphalt actually improved the temperature problems. First of all, concrete warps with temperature change which results in more frequent cracking. An A-R thermal blanket reduced the curling stresses on concrete by 8 to 25%. Additionally, because concrete roads are much thicker, denser and heavier than their asphalt counterpart, its greater mass results in longer temperature retention. So, even though the asphalt heats up more quickly than the concrete, because it is thin and porous, its heat is quickly released and doesn't greatly affect the atmospheric temperature. In contrast, the heavy concrete holds a great deal of heat and will slowly release that heat into the air during a cool night.

In conclusion, thin A-R overlays have many benefits to road systems. A road with A-R will have improved performance and durability, improved safety and ride quality, less highway noise, it retains less heat, it is cost effective, and as an added perk, its use results in a positive environmental impact because of recycling and improved fuel efficiency.

Tire Recycling in TxDOT

A presentation by Gerald Peterson

How recycling benefits TxDOT

TxDOT is committed to recycling and has always been innovative in environmental protection as they continue road system projects. Not only is it environmentally friendly, but using recycled material creates a better bottom line: there is relief on regional material shortage, native materials are conserved, environmental standards are met, construction costs are reduced, hauling and disposal costs are reduced, and markets for scrap materials receive support.

These saving are made clear by recent totals compiled by TxDOT of the economic benefits coming from the use of recycled materials. For example, use of RAP, recycled concrete and fly ash translated to a purchase cost savings of $40 million and a disposal cost savings of $19 million. Because the use of recycled materials results in savings such as these, TxDOT has used literally millions of tons of recycled material despite the fact that TxDOT does not mandate the use of recycled material. Rather, TxDOT allows recycled materials providers to compete equally with all other material providers.

2.8 million tons	Reclaimed Asphalt Pavement
948,000 tons	Recycled Concrete Aggregate
240,000 cu yd	Compost
200,000 tons	Fly Ash
3,600 tons	Glass Traffic Beads
7,800 tons	Crumb Rubber
2,300 tons	Cellulose Fiber Mulch

Rubber in Texas

Tire rubber in the state of Texas has mostly been used in tire derived fuels (at 61%). The next largest use comes from land reclamation projects using tires (at 25%). In land reclamation projects, tires are used to replace earth lost in strip mining operations or to create roadside embankments. Crumb rubber, such is used in asphalt rubber, stands at only 6% of the recycled rubber.

Despite being far from the leader in recycled rubber use, TxDOT still managed to use 8,000 tons of tires in 2009 for a variety of applications. Three-fourths of this rubber was put to use in the application of chip seals which is clearly the most common use of recycled rubber at TxDOT. The remainder of the rubber was put to use in A-R hot mix overlays and embankment projects.

While tires must be processed and transformed into crumb rubber before use in asphalt-rubber, scrap tires and tire bales can be used in embankments after minimal processing. Tire bales, such are used in the formation of roadside embankments, are merely discarded tires bound together in two-cubic-yard bales. These one ton bales are stacked up like bricks and covered with dirt to form embankments. Often tire shreds are used as added fill because they are durable and allow for free-draining.

Figure 3 Tire Rubber Roadside Embankment

TxDOT has found other miscellaneous uses for recycled tires as well. Examples of such applications include guardrail spacer blocks because the rubber is long lasting and easy to install, the inside of delineator posts because the rubber makes them more durable and resilient, and as vegetation control mats under highway signs. While these applications do not account for much of the recycled rubber use in the state of Texas, these innovations display TxDOT's commitment to finding creative ways to use recycled materials for projects that could be using non-recycled materials.

Figure 4 Tire Rubber Guardrail Spacer

While those are all examples of recycled rubber used with very little processing, the vast majority of rubber used at TxDOT must first be turned into crumb rubber before becoming one of the two kinds of rubber used at TxDOT. The first and most common, asphalt rubber (A-R), has tire rubber particles at approximately 15% of the mixture and has an oatmeal appearance. This form of rubber is used in applications such as TxDOT item 318, A-R seal coat. The second is called high-cure tire rubber (TR), which has been cured at high temperatures for several hours and has no visible rubber particles. It can be used like any other asphalt, but is mainly put to use as a premium seal coat binder (which stands at 40% of TR application). However, TR is also often used to modify PG binders in any hot mix.

Figure 5 A-R left / TR right

Seal coats with A-R

The most common use of A-R is in seal coats where asphalt is sprayed on to a surface followed by application of cover stone. It may also be applied as final base treatment between hot mix layers, or as a final riding surface or friction course.

Because Texas maintains more rural roads than any other state, there is always a need for a large quantity of contracted seal coats (about 16,000 lane miles per year contracted, and about 3000 lane miles of state force seal coats per year). These seal coats have an average service life of 6 to 8 years. Seal coats are good preventive maintenance due to their ability to keep water from penetrating the pavement surface to reach the base. Keeping moisture out of the base of a pavement is the best way to fend off irreparable structural damage. Frequent application of seal coats will reduce the possibility of a pavement falling into poor condition where expensive, reactive maintenance measures are required for repair.

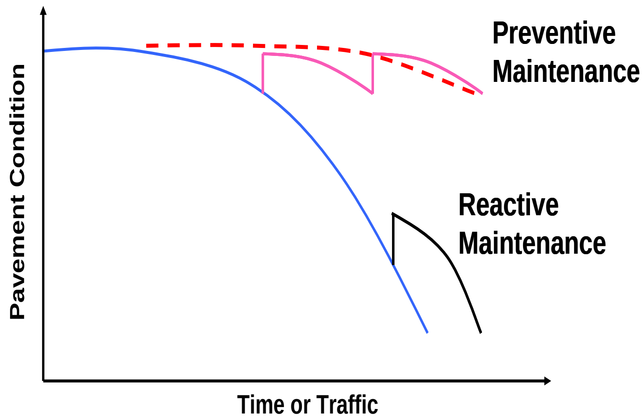

Figure 6 Pavement Preservation Timeline

These functions of seal coats are more effective the more asphalt that is in the seal coat mixture. This is because it is the asphalt, not the aggregate that creates the seal. However, too much asphalt will cause flushing and the aggregate is necessary to keep the car tires out of the asphalt and to provide a skid resistant surface.

Use of A-R and TR

TR and A-R offer similar benefits. Both allow for the use of more asphalt which creates a better seal, allows for deeper aggregate embedment and better chip retention, and the application is more forgiving. Additionally, the seal coat service life is extended with the use of rubber. The difference in TR is that dissolved rubber asphalt attempts to reuse the polymers that are in the tire rubber. But, using the rubber in the way, that is, melting the rubber down rather than using crumb rubber particles misses out on tire rubber particle properties.

When used in hot mix application, asphalt-rubber improves the properties of the mixture greatly. A-R effectively stiffens the mix, provides draindown resistance, and prevents reflective cracking – especially prevalent in PFC open grade mixes where the mix is generally very porous. Because of this, PFC mixes drain water off the road quickly so there is reduced spray, glare, and hydroplaning: all properties of a better friction surface.

The superior performance of A-R PFC mixes in wet weather conditions was made clear by a case study done on Interstate 35 in San Antonio. A PFC overlay was placed on existing concrete pavement. The pavement had relatively sound structure despite being 20 years old, but the ride quality was poor and skid numbers were in the single digits. A one and a half inch A-R overlay was placed on top of the road. This overlay improved ride quality by approximately 60%, reduced noise level by at least 8dbs, and wet weather accidents were cut nearly in half despite more wet weather days than the previous year.

Figure 7 Wet Weather Conditions Before and After A-R Overlay

Impact of Recycling

The Waste Tire Recycling Program in Texas from accumulated 75 million waste tires from 1993 to 1997. This enormous tire pile was reduced to 25 million by the end of 2006, and more tires were recycled than produced in both 2005 and 2006.

Picking the right road

Future of seal coat use hopes to promote competition in their material selection with help from a materials guidance table promoted by the TxDOT administration. This table will help in the selection of proper seal coat materials by showing which options are too expensive for many low traffic volume roads.

In this "materials guidance table," roads are divided into tiers based on traffic levels. Each of the three traffic level tiers have different binders associated with them. Any binders from that tier, or any tier above it, would be appropriate for the maintenance operation in question.

Use of recycled materials in the future

The future of hot mix at TxDOT will be SP 341-024 for dense grade mixes. This new product with many new additives will bring down the cost of hot mix materials. The new binder promotes the use of recycled asphalt pavement and recycled asphalt shingles – further evidence of how TxDOT can make an industry out of recycling.

Over the past few years, TxDOT has been shifting their focus to maintenance. Previously, TxDOT received most of their money from the gas tax, but with fuel efficient vehicles on the rise, the income from the gas tax is becoming less and less. So, funding for expensive projects is no longer available as the transportation budget continues to drop, so cost efficient preventative maintenance projects are getting more attention. Research projects are also shifting towards the maintenance side of TxDOT activities.

While the benefits of using recycled rubber in asphalt mixes has become obvious to pavement engineers, wildcard factors exist in the use of tire rubber: oil prices (material haul costs, asphalt availability, tire usage), transportation budgets, new technologies, and shrinking tire piles may all contribute to recycled tires becoming a depleting resource.
In order to facilitate their use, transportation officials must treat the material like a product by protecting it from loss or damage, by keeping a proper inventory of availability, and keeping tires separated from other wastes. Additionally, it will remain important for TxDOT to continue to find ways to encourage recycling through research and product innovation.

Figure 8 Scrap Rubber Yet to be Put to Use

Pavement Preservation Strategies and Application of Asphalt-Rubber

A presentation by Dr. Yetkin Yildirim

For years, the traditional approach to road maintenance has been used on our nation's roads and highways. This approach concentrates all of our resources on corrective maintenance, or maintenance that must be done in response to events that cannot be planned, or as reactive repairs. Research that has been put into the aging of our road systems has revealed that pavement preservation is a far more effective and cost efficient method of maintaining roads. This preemptive effort to preserve the structural integrity and functional condition of our roadways has been on the table for the past three decades, but has been strongly promoted in the past ten years.

A healthy road

In order to understand why the traditional approach is no longer a viable method, a better understanding of our roads is required. First of all, the pavement must have good structure. This means that it requires fine drainage, a strong foundation, and acceptable thickness. These properties all get exponentially worse with time. Pavement preservation attempts to never let pavement fall below "period I" in its three period aging process. Because minor cracks allow water to seep through the pavement resulting in more extensive damage, the cost to repair the pavement rises exponentially as its age increases. Additionally, retroactive maintenance will never bring the pavement back to its original quality.

A proper pavement preservation strategy addresses the pavement while it remains in good condition. If the onset of serious damage is allowed to occur, cost effective treatment will no longer be an option. However, if maintenance begins early, the road will have a much better chance at remaining in its original condition. The key to effectively achieving this is to understand what causes the physical wear and tear on the pavement. Knowing the source of the problem will result in a better ability to stave off the effects.

When considering whether a road needs work, certain things must be taken into account. The existing pavement condition, the climate and weather conditions surrounding the road, the properties of the materials available, the traffic load expected on the road, and local restriction are all important factors to consider when deciding whether a road needs improving. In short, it must be determined that it is the *right* treatment for the *right* road at the *right* time.

Seal coats and asphalt-rubber

Once the right road is identified for maintenance operations, a seal coat will likely be applied (if the pavement has not fallen too deeply into a state of disrepair). Tire rubber asphalt has become a popular component of seal coats at TxDOT in the past few years. Its popularity has occurred for a reason as asphalt rubber has many benefits over other alternatives. Asphalt rubber reduces reflective cracking in asphalt overlays, it improves resistance to cracking, it improves resistance to rutting, it increases pavement life, it improves skid resistance, and it decreases noise levels. What's more, asphalt rubber is responsible for the beneficial use of 500 to 2,00 scrap tires per lane mile of maintenance operations.

Figure 9 Crack Seal

The only true way to make sure that these decisions are properly made comes from education and training. Both the Center for Transportation Research, and Texas Transportation Institute provide training in the area of pavement preservation. Many online courses are available at the center's website. These courses are free, will further understanding of pavement preservation, and are interactive, user friendly, and accessible from any computer with internet access.

Stress Absorbing Layers

Additionally, the CTR and TTI share pavement preservation technology, as well as study proper research implementation and strategic planning for research. Such research spearheaded by TPPC has made helpful innovations on seal coats, crack sealing, thin asphalt overlays, and warm mixes. A new patent by TPPC, a stress absorbing layer for seal coats, has offered a method for enhancing the performance and providing longer service life to existing roadways. In three tests, the seal coat was tested against a control group on different roads around the state of Texas and was monitored for three years. First, stress absorbing layers for seal coats were applied on the existing cracks on the test sections. After application of stress absorbing layers, seal coats were applied on the test sections and control sections were constructed without the application of stress absorbing layers. These tests found that test sections with stress absorbing layers showed superior performance in comparison with the test sections without stress absorbing layers – cracks did not show up on the surface of seal coats where stress absorbing layers were used. This new procedure keeps the cracks sealed and extends the life of the seal coat by three to five years. Inventors at UT, Austin at the CTR have developed a compound and documented its ability as a stress absorbing layer to enhance performance. One of the main components used to develop the stress absorbing layer is asphalt rubber.

Figure 10 Seal Coat with Stress Absorbing Layer in Foreground - without Layer in Background

In summary, pavement preservation programs extend pavement life, preserve structural integrity, enhance pavement performance, slow progressive failures, improve safety, improve ride quality, ensure cost-effectiveness, and improve mobility. Despite the obvious benefits of pavement preservation programs over traditional methods, these benefits will not be realized without proper training and education of our transportation service industry and the local, state, and nationwide policy makers.

Badly Deteriorated Pavements and Asphalt-Rubber

A presentation by Mahmoud Mahmoresi

Asphalt-rubber has been a viable product since the 1970s, but it has not always been as popular of an option as it is today. A couple decades ago, most asphalts were about half the price of asphalt-rubber. Today, asphalt prices have gone up considerably, but asphalt-rubber has gone up in price only very little due to recycling practices. With asphalt-rubber now standing as a cheaper alternative to many other options, its use has become more and more common.

More often than not, scheduled maintenance operations get postponed year after year because more important projects use up the entire maintenance budget. Because of this, pavements that should have preservation measures taken on them after seven or eight years will sometimes not have work done on them for twelve to fifteen years. As a result, previously planned maintenance procedures may no longer be viable and it is incredibly important to pick the options that will add the most years of service life to the pavement in question at the lowest possible cost.

Figure 11 A road that has missed its scheduled maintenance

An asphalt-rubber seal coat is likely the answer. However, because pavements are allowed to degrade beyond their planned level of disrepair, pre-maintenance measures must often be taken in order to get a pavement ready for a seal coat. Crack sealing and patching of the pavement prior to application of a seal coat is an effective strategy in rehabilitating pavements that have fallen below their planned level of disrepair. For example, active thermal cracks are too severe for a seal coat alone to take care of the problem. First, the crack must be filled before a seal coat can be placed on top.

Figure 12 Typical Thermal Crack

Additionally, before application of an asphalt-rubber seal coat, it is important to patch all large chunks missing from the roadway, to remove and replace all base failures, and it's always a good idea to use crack sealing around patches. It is not obvious how much patching is too much before seal coat application. In a road in poor condition, the very least that needs to be done is to patch all of the pot-holes that have developed. So, the pre-maintenance that is performed depends on the conditions of the existing pavement.

Once a pavement is ready for the seal coat, a mixture of approximately 20% crumb rubber and 80% AC-10 is commonly used as a seal coat material. The application rate for the A-R binder is approximately .55 to .75 gallons per square yard with 26 to 36 pounds per square yard of aggregate. If the road is not too badly cracked, the A-R binder rate could be as low as .45 per square yard. The worse the road, the greater the application rate must be for the A-R binder.

One of the unique things about asphalt-rubber is the need to have specialized equipment on site because crumb rubber does not stay in suspension for very long. Agitated spreader trucks must be used. The material must practically be made on site to be used while it is still fresh. It will take the mixture about one hour of interaction time before the crumb rubber has had a chance to absorb the asphalt and expand. When ready, the viscosity of the mixture must be at a minimum of 1,500 cP at 375 degrees F. During the application process, using pre-coated aggregate is a must when dealing with asphalt-rubber. If pre-coated aggregates are not used, dust particles will interfere with aggregate embedment because the viscosity of the A-R material is so high that it almost immediately turns into a gel after being released from the sprayer.

Figure 13 Agitating Spreader Truck

Though A-R seal coats are often a good choice for preventative maintenance, urban and suburban areas are less likely to use a seal-coat because of the risk of loose aggregate causing harm to vehicles and pedestrians. In these situations, a cape seal is a viable alternative. A cape seal is when a road has a seal coat applied to it, but then a slurry seal is placed over the surface of the seal coat in order to smooth out the riding surface. This procedure is a viable option for urban and suburban roads where a smooth road surface is desired.

Figure 14 Cape Seal on a Suburban Road

In conclusion, the use of A-R seal coats in pavement preservation measures has many benefits: a higher binder application rate is possible, there is improved resistance to reflective cracking, the road will have a longer service life, there will be a higher percentage of aggregate embedment and retention, it has better temperature susceptibility, it takes less construction time, it is an alternative to reconstruction, it may be used on in a variety of situations on many different types of roads, and it has a low initial cost when compared to alternatives.