FREQUENTLY ASKED QUESTIONS

ACE Fiber

Why should we consider using ACE Fiber?

ACE Fiber is a fiber for reinforcing asphalt. It is made of wax (Sasobit) binder and Aramid (Kevlar). The Aramid has 5X the tensile strength to that of steel and a melting point of 800°F. Most importantly, the Aramid develops micro-roots which grab into and reinforce bitumen (liquid asphalt). Aramid has shown to increase the strength, crack resistance, rut resistance, fatigue life, toughness, and service life of an asphalt concrete (A.C.) mixture. ACE Fiber is unique because its wax binder completely melts away in the asphalt mixing process evenly dispersing the Aramid fiber throughout the mix.

How much does ACE Fiber cost?

In general, ACE Fiber adds between 10% and 20% to the cost of A.C. depending upon your local asphalt mix tonnage price.

Is ACE Fiber worth paying 10% to 20% more for?

Using a calculated amount of Aramid Fiber can increase the life of your A.C. pavement by 50% to 85%. Paying 10% to 20% more for A.C. mix that performs over 50% better than standard A.C. mix is the simplest financial justification for using ACE Fiber. However, because ACE Fiber adds structural strength to asphalt layers, you may consider a small thickness reduction to pay for the ACE Fiber yet still see a service life increase up to 30%. Any reduction in thickness will have to be assessed on a case by case design basis.

How do you know that ACE Fiber increases performance of A.C. pavement?

Testing on ACE Fiber has produced results showing 140% increase in crack resistance and 60% increase in rut resistance. Aramid has also been the subject of numerous U.S. and international asphalt performance studies since the mid 1990's. Fiber additives for A.C. have a history dating back more than 40-years, but it has been the recent advancements in materials and the way pavement researchers test and quantify performance that has confirmed the reliable performance predictability of Aramid for A.C. pavements. The combination of historical and recent research, testing, and case studies demonstrates the active material in ACE Fiber significantly enhances A.C. pavement performance.

What is unique about ACE Fiber?

Raw and untreated Aramid Fiber can physically blow away or get sucked into an asphalt plant bag-house when trying to feed it into an asphalt mixer. Raw Aramid fiber also has a tendency to stick together and "clump" in the feeding and mixing processes, which means the fibers do not distribute evenly or thoroughly in the plant's mixing chamber. Because Aramid fiber is a very lightweight and difficult material to work with, Surface Tech pre-treats its Aramid fibers by soaking them in

a wax binder. This pre-treatment weighs down these lightweight fiber clips and prevents them from blowing away or clinging together during the delivery and feeding processes.

ACE Fiber's unique pre-treatment controls the delivery and feeding processes. Once in the mixing chamber, the binder wax treatment on the fiber clips melts to release the individual Aramid fibers while they are being blended with the hot aggregate and asphalt. ACE Fiber, therefore, mixes Aramid fibers thoroughly and completely throughout the entire asphalt mix without blowing away or clumping like untreated raw Aramid does.

What does ACE Fiber do in asphalt concrete?

Simply put, traditional A.C. is "rocks and glue." While the aggregate (rocks) in A.C. provides compressive strength and wearing resistance, the asphalt (glue) is the binder that holds the aggregate together and provides tensile strength. Asphalt concrete, while a practical and smooth pavement, has properties vulnerable to temperature changes. When cold, it has a tendency to become brittle and crack, and when warm/hot it has a tendency to soften and flow, which leads to rutting. Since Aramid is a fibrous tensile solid, its properties remain constant whether it is cold or hot. When the asphalt is cold, ACE Fiber will help resist the cracking effect of A.C. by adding significant tensile strength. When A.C. is warm/hot, Aramid fibers resist rutting because the fibers are imbedded and rooted in the asphalt to resist flow. The high strength fibers in ACE Fiber significantly increase the tensile and binding strength of A.C. in all weather, which significantly improves its performance properties immediately and over time.

How much ACE Fiber is added to the A.C. mix?

The weight of ACE Fiber added to the A.C. is no less than 4.2 ounces (coated weight) and no more than 8 ounces (coated weight) per ton of total A.C. mix. This may not sound like much but Aramid is a very lightweight material. ACE Fiber is approximately 50% Aramid and 50% wax by weight. So, once the wax melts, 2.1 ounces of pure Aramid is dispersed and mixed throughout the A.C. mix releasing over 18 million Aramid fibers.

How do we use or design asphalt concrete pavements with ACE Fiber?

We have four different approaches to A.C. pavement designs with ACE Fiber:

1. **Standard Practice** – This method is simply using Aramid fiber's performance enhancements and applying them to what you currently do:
   - Asphalt roads see a lot of stresses from the top (sun, thermal, oxidation, etc.) and bottom (subgrade movement). Consider all the busy intersections, bus lanes, loading areas, and challenging road sections that have a history of cracking/rutting or failing prematurely. If an agency wants to have longer lasting A.C. pavement, it can simply add ACE Fiber to their mix. ACE Fiber adds extra reinforcement to all asphalt at an extremely low cost.
   - If a street maintenance department normally lays down 3-inch A.C. overlays every year and they have historically been effective, they can now reduce their sections to 2 inches with ACE Fiber without sacrificing performance. This will save them approximately 25% on costs so they can do 25% more overlays, stretching their maintenance budget - being mindful of all considerations assessed during design.
   - The last option in the standard practice approach, and easiest one to justify, is to reduce whatever your A.C. pavement section is by 0.25 inches and capitalize on increased performance for no extra costs—zero net effect on the pavement maintenance budget. The 0.25 inch thickness reduction approximately offsets the cost of the ACE Fiber but the slightly thinner section will be stronger and longer lasting than the standard A.C. section without fibers, up to 30% more based on local conditions.

2. **Modified Structural Numbers/Layer Coefficients** – Depending upon which pavement design method is used, pavement engineers can design A.C. pavement sections with ACE Fiber by modifying their structural numbers or layer coefficients in their design programs. For instance, if a pavement designer is using AASHTO, they can use an enhanced layer coefficient in their design program for the asphalt layer because the fiber mixed asphalt has significantly higher performance characteristics. The pavement designer can then decide how to use the enhanced asphalt performance for thinner asphalt, aggregate, or other layers to save costs, increase life, or a combination of both. Nilex Inc. should be engaged should this be a desirable approach.
3. **In Lieu of Crack Relief Interlayers or Performance Grade Asphalt** – The added cost, labor, and time required to install Crack Relief Interlayers is tremendous. The simplicity of adding ACE Fiber into asphalt mix at the plant is far easier and cost effective. Not only is the process easier and less costly, you actually get more performance with enhances to rut, fatigue and thermal resistance in addition to crack control. ACE Fiber in standard asphalt grade (PG64-22) may also be a great alternative to higher asphalt grade (PG70-22 or PG76-22) mixes.
4. **Value Engineering** – Alternative asphalt overlay and new pavement designs in any of the preceding options can be utilized through a Value Engineering process.

Is ACE Fiber difficult for asphalt plants to mix?

No. For batch plants, the proper batch size amount of ACE Fiber is put into the weigh hopper and mixed as usual. For drum plants, ACE Fiber is manually or mechanically fed onto the RAP belt or blown into the RAP collar at the rate the drum is mixing A.C. ACE Fiber is sold with a QA/QC on-site mixing service included. Ace Fiber will be mixed into the A.C. by a trained and certified third-party engineer's technician. This will free the producer to concentrate on making A.C. and the on-site technician will take care of the rest, coordinating with the pilot house on starts and stops and plant manufacturing speed changes. Once completed a P.E./P.Eng. sealed certification report will be issued stating that the Ace Fiber was properly mixed into the A.C. per plans and specifications. This mixing service is included in the price of every ACE Fiber project sold.

How do we know the fibers are properly mixed?

Pre and post mixing reports are part of the QA/QC on-site mixing service to ensure that the proper amount of ACE Fiber was added to the amount of A.C. mixed. This is because ACE Fiber enters the mixing chambers at the same point that asphalt and aggregate are mixed, the only place the fibers can go is in the mixture. ACE Fiber is pre-treated so that the fiber filament clips drop into the asphalt mixture and disperse uniformly with the mixing of a batch chamber or the spinning of the drum chamber. The individual fibers are also visible upon inspection of fresh asphalt mix.

Do paving crews have to do anything different when ACE Fiber is in the asphalt?

No. ACE Fiber is very fine and does not cause any changes to the working characteristics of A.C. Fiber reinforced A.C. goes through the paver the same, can be raked and shoveled the same, and can be compacted the same.

Do the fibers in the asphalt mix change compaction or compaction testing?

No. ACE Fiber reinforced A.C. compacts the same as standard asphalt. The standard density testing equipment like nuclear gauges can still be used without any effect from the fibers.

Is ACE Fiber A.C. more difficult to grind or mill?

No. Grinders and milling machines have no problem with aramid fiber mixed A.C.

Can ACE Fiber A.C. be recycled as RAP?

Yes. Aramid fibers are very fine and do not negatively affect the RAP quality when milled. We currently do not have any data on whether RAP with ACE Fiber has any enhanced performance value but we know it does not harm the quality of the RAP.

Do the fibers stick up or have a different surface appearance than standard A.C.?

No. ACE Fibers are very fine and when mixed with asphalt and compacted, they do not stick up or show on the surface of the pavement.

Can ACE Fiber be used in warm mix asphalt or porous asphalt pavements?

Yes. However, some add mixtures used in warm mix asphalt may not allow the ACE Fiber to completely disperse. Nilex Inc. should be engaged to determine the type of any anti-stripping agents that you might be using in your warm mix to verify compatibility.

Can ACE Fiber A.C. qualify for LEED, ISI Rating, or Greenroads points?

Yes. By using Aramid fiber A.C. in your project, you are using thinner and/or longer lasting pavement materials. This will result in less aggregate and asphalt needed and/or less long-term maintenance. These benefits will result in less mining, trucking, energy, and manpower for a lower carbon footprint.

When would you NOT use ACE Fiber in A.C.?

When you do not want better performing, more cost effective, and more sustainable A.C. pavements. The only situation that we can think of where ACE Fiber should not be considered is when you are getting your A.C. for free.

Why are fibers for concrete so common and fibers for A.C. uncommon?

Great question. It's the manufacturers' opinion that "the cost and different mixing methods between A.C. and concrete have "held back" the use of fiber in A.C. and "moved forward" the mass use of fiber in concrete".

Historically, A.C. has been an inexpensive roadway pavement material while concrete has been an expensive roadway pavement material. Twenty years ago, the value proposition of adding an "expensive" fibrous material into asphalt to improve performance was not there. It was easier and not much more expensive to add a couple more inches of asphalt to obtain the needed performance for a pavement section, for instance. However, over these last 20 years there has been an increased price of oil along with an increased expense of mining and trucking aggregate, A.C. costs have raised significantly. Regardless of what has been tried to improve the service life of asphalt roads, for the most part, the owner still wants more performance. It is clear, that this improved performance will not come from a traditional asphalt approach.

The value proposition of fiber additives in concrete has been more consistent because concrete pavement costs have always been relatively higher than asphalt. It is well known that fiber provides significant performance enhancements to concrete including increased strength, reduced cracking, higher ductility, increased fatigue life, and increased toughness. There are many different reinforcing fiber materials for concrete including polyester, fiberglass, steel, and polypropylene.

The other main factor that has "held back" the use of reinforcing fiber additives for asphalt and not concrete is the way they are mixed. Concrete is mixed at ambient temperatures in batches so many different types of fibrous materials have been used to reinforce concrete for decades. A.C., on the other hand, is mixed at approximately 350°F, which limits the types of fibrous materials that can survive the mixing process with performance enhancing properties. Most of the fibers used in concrete cannot maintain their reinforcing characteristics when mixed with 350°F oil and over 350°F heated aggregate. Fortunately, with the development of materials like Aramid

into fibers, we have found a fiber that has the heat resistance and strength to withstand the harsh mixing environment of A.C. and still maintain its high strength and reinforcing characteristics. Aramid used to be protected by DuPont's patent but since the patent expired, Aramid is made by multiple manufactures at competitive prices. The value proposition of using Aramid in A.C. now makes economic sense.

What agencies have used fiber additives in A.C.?

By our estimation, every DOT in the U.S. has used fiber additives in certain asphalt mixes. The most common DOT mix that uses a fiber additive is called stone matrix asphalt (SMA). SMA has been used for almost 15 years in the U.S. and has been described as the best performing asphalt pavement mix design for durable wearing, rut resistance, and crack resistance. The fiber used in SMA provides stability and has a filler quality that enables proper distribution of the highly polymerized asphalt used in the mix.

Aramid fiber not only provides stability characteristics, it also adds significant reinforcement to all types of A.C. mixes. We estimate that reinforcing fibers for A.C. have been used in 35 U.S. states now. The FHWA has also provided a directive in the most recent President Obama signed transportation bill, MAP 21, for DOTs to use fiber-based reinforcing additives in A.C. to potentially help our infrastructure last longer than it currently does. MAP 21 also has directives for DOTs to use innovative and more effective materials in pavement maintenance methods. Therefore, the use of fiber additives for A.C. will continue to gain more widespread, if not universal, adoption in the coming years.

What are the material properties of reinforcing fibers for A.C. pavement?

The most effective and active fiber material used to reinforce A.C. is Aramid. This unique fiber material has the physical properties that survive the A.C. mixing process and significantly enhance the performance of A.C. pavements. The important material properties of these fibers include:

Active Material	Aramid
Length	19mm (0.75") and 38mm (1.5")
Form	Wax Pre-treated Filament Clips
Color	Yellow
Specific Gravity	1.44 g/cm3
Melting Point	800°F
Acid/Alkali Resistance	Inert
Tensile Strength (min.)	400,000psi
Amount per Ton	2.1 oz. (approx. 18M fibers)

When to consider ACE Fiber?

- All asphalt pavement (new pavements and overlays): 1.0" and thicker
- ACE Fiber does not require new mix designs for asphalt
  - Very small volume of ACE Fiber required (4.2 ounces per ton, 131.2 grams per tonne)
  - Does not "soak up" oil and require more asphalt
  - Volumetric ratios do not change
- ACE Fiber may be included in all asphalt course mixes (surface, intermediate, base)
  - 3/4" long fibers blend uniformly with all aggregate sizes for the different courses
- ACE Fiber may be included in Performance Grade asphalt and polymer blends
  - ACE Fiber can help higher grade asphalt mixes resist cracking caused from the brittle nature of these blends
  - ACE Fiber in standard asphalt mix (PG64-22) is a great value alternative to higher grades (PG70-22, etc.)

What is the Structural Number (SN) Increase with ACE Fiber?

Published papers (Arizona State University) recommend an increased SN by 20%-40%. The scale of increase is based on subgrade condition because you would not expect constant performance increase percentage over all conditions. Nilex Inc. should be engaged to assist with preliminary designs.

What is ACE Fiber's Competitive Advantage?

ACE Fiber is pure Aramid with a wax treatment. By treating the Aramid with wax, the Aramid is weighted down and controlled for proper delivery into the asphalt mix. When ACE Fiber enters the asphalt mixing chamber, the wax melts to release the fibers in the right place at the right time.

Other competitors use a blend of loose (untreated) Aramid and polypropylene fibers. Loose Aramid is lighter than a feather and either blows away or gets sucked up into the baghouse (fines filter) in the asphalt mixing chamber. Also, the polypropylene fibers have too high of a melting point to mix properly in drum mixing plants and is less likely to perform as advertised because the fibers will not get distributed throughout the mix.

The objective for any FRAC project is to thoroughly blend 2.1 ounces of Aramid fiber in asphalt mix. Mixing less than 2.1 ounces of Aramid per ton will result in lower performing asphalt.

Is there any impact of wax on AC and aggregate cohesion?

No impact (negative or positive).

We use steel slag in our mixes. As slag is more porous than natural aggregate, will there be any waist of fiber entering the pours of the slag instead of dispersed in the mix?

We have not tested this condition. However, from installation experience to date, the manufacturer strongly believes that the fibers would not lodge into the pours of slag during asphalt production.

Would mixing time in the pug mill need to be increased?

There has not been a need to increase mix time in any of the batch installations (over standard mixing times). The manufacturer does not believe ACE Fiber will call for additional mix time with slag asphalt either.

How are the fibers used during the mix design process? We use Marshall method, would there be any adjustment needed for mix design process?

There is no effect on the mix design process. This is because the amount of fiber we introduce is very small (2.1 ounces of Aramid per ton). Yes, we also introduce 2.1 ounces of Sasobit Wax per ton, however this small amount becomes completely soluble in the asphalt and does cause change mix design process either.

What is the length of the fibers?

ACE Fiber is available in 19mm (0.75") and 38mm (1.5") lengths.

The melting point (800 F) is ~427C, our burn oven starts at 450-460C and peaks between 500-550C. If the fibers melt and stick to the aggregate, does it give us an incorrect sieve or is this taken into account in the mix design process? Would the fibers burn at that temperature?

Yes, it is likely the fibers will burn at those temperatures; however, you may see some residue of fiber.

Does the mix get "stickier"? Would it behave different when being dispensed from pug mill, silo or the track box?

Absolutely not.

Considering that the weight of fibers added to an average batch of four tonnes is about 0.5 kg do you use separate weigh hopper while dozing it into the aggregate? Would it make sense to have weigh the fibers and then drop it directly to the pug mill during dry mixing or wet mixing?

Our technicians weigh/scale and deliver the portions of ACE Fiber required for each

project. We do this at the plant during production for each job. For batch operations, the portions are scaled based on the tonnes per batch. Our target dosage is 4.2 ounces per ton (converted is 0.108 kg per tonne). So, for a four tonne batch, we would feed 0.432 kg. We would feed this amount into either the weigh hopper or the pug mill, depending on which is easier to access with our line-vac tube.

We are currently not using RAP but are planning to use them in the future by feeding them into bottom of hot elevator. Feeding fibers at the same spot would most likely melt the wax on the way to the top of the hot elevator and potentially some of the fibers would get blown into baghouse. Please comment.

We would prefer to line-vac our fiber through a tube directly into the weigh hopper or pug mill, and not place on the RAP. For further clarification: The accuracy of the measurement in the field is with the apparatus shown in the picture “705.jpg” (0% under, 3-5% over our specified dosage rate of 0.108 kg per tonne). Also, on occasion there is concern that the WAX was melting on the RAP due to the heated elevator. Hence the suggestion that we bypass the RAP elevator and blow the fiber directly into the weigh hopper, or pug mill.