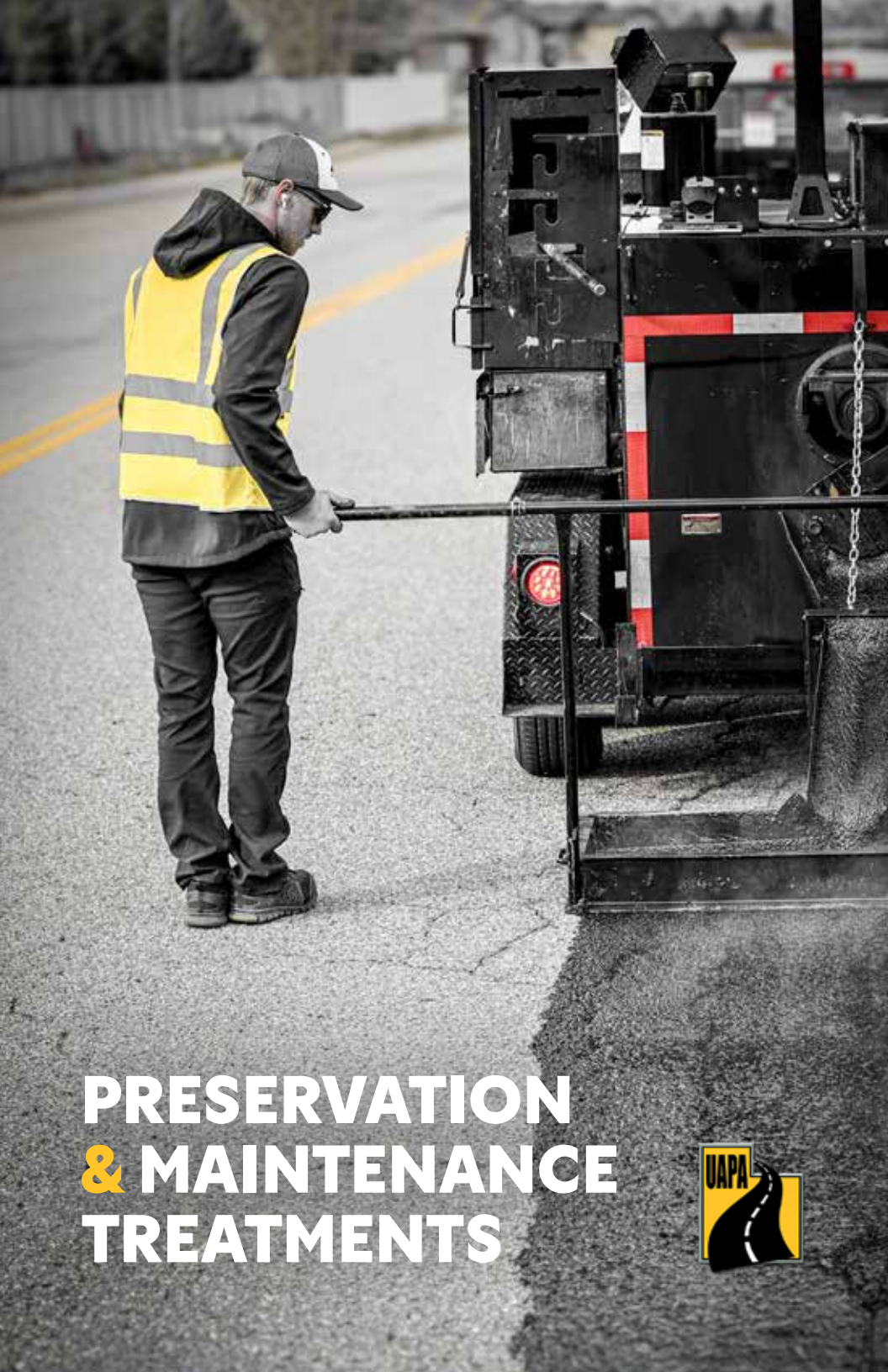

PRESERVATION & MAINTENANCE TREATMENTS

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ALLIGATOR OR FATIGUE CRACKING

Alligator cracking is a type of asphalt pavement damage that occurs when a series of cracks form a pattern that resembles an alligator's skin or the scales of a reptile. It's also known as fatigue cracking or crocodile cracking.



Alligator cracking is caused by issues with the underlying layers of asphalt, such as:

- The subgrade may not be thick enough, properly prepared, or allow for adequate drainage.
- Water can seep into the pavement and cause cracks.
- Extreme temperatures can cause the asphalt to expand and contract, leading to cracking.
- Vehicles with heavy loads can cause the pavement to sink, creating an uneven surface.
- Incorrect installation methods or poor choice of materials can lead to premature deterioration.

To prevent alligator cracking, you can:

- Ensure proper installation of the asphalt's subbase.
- Maintain sealcoating every two to three years.
- Prepare for cold weather by clearing debris, filling cracks and using cold mix asphalt.
- Fix parking design to prevent excess traffic load.

FLEXIBLE PAVEMENT PRESERVATION TREATMENT MIX

SEVERITY	**LOW** (Very Mild)	**MEDIUM** (Noticable, But Not Extensive)	**HIGH** (Extensive In Most Locations)
CRACK FILLING	RECOMMENDED	FEASIBLE	NOT RECOMMENDED
CRACK SEALING	RECOMMENDED	FEASIBLE	NOT RECOMMENDED
SPRAY APPLIED PRESERVATION	NOT RECOMMENDED	NOT RECOMMENDED	NOT RECOMMENDED
REJUVINATOR /FOG	NOT RECOMMENDED	NOT RECOMMENDED	NOT RECOMMENDED
SAND SEAL	RECOMMENDED	FEASIBLE	NOT RECOMMENDED
SCRUB SEAL	RECOMMENDED	FEASIBLE	NOT RECOMMENDED
SLURRY SEAL	FEASIBLE	NOT RECOMMENDED	NOT RECOMMENDED
CHIP SEAL	FEASIBLE	NOT RECOMMENDED	NOT RECOMMENDED
MICRO SEAL	FEASIBLE	NOT RECOMMENDED	NOT RECOMMENDED
CAPE SEAL	FEASIBLE	NOT RECOMMENDED	NOT RECOMMENDED
CIR	RECOMMENDED	RECOMMENDED	FEASIBLE
HIR	RECOMMENDED	RECOMMENDED	NOT RECOMMENDED
HMA OVERLAY (Less Than 2")	RECOMMENDED	FEASIBLE	NOT RECOMMENDED
BWC (Less Than 1")	RECOMMENDED	FEASIBLE	NOT RECOMMENDED
ULTRA THIN HMA (0.5" - 1.0")	RECOMMENDED	FEASIBLE	NOT RECOMMENDED

BLOCK CRACKING

Block cracking is a type of asphalt pavement damage that appears as a network of large, rectangular or square-shaped cracks.

Block cracking is caused by a combination of factors, including:

- The asphalt can't flex due to temperature changes, causing it to shrink.
- The asphalt binding agent hardens and becomes brittle.
- The wrong binder may have been used in the asphalt mix design.
- The aggregate may have been too dry when it was applied, or it may have dried out over time.
- There may have been problems during the asphalt manufacturing process.

To prevent block cracking, you can:

- Sealcoat your asphalt every three to five years or more often if your parking lot is heavily used.
- Clean your parking lot regularly to extend its lifespan.
- Keep a close eye on your parking lot to identify any signs of block cracking as soon as they appear.

FLEXIBLE PAVEMENT PRESERVATION TREATMENT MIX

SEVERITY	**LOW** (Very Mild)	**MEDIUM** (Noticable, But Not Extensive)	**HIGH** (Extensive In Most Locations)
CRACK FILLING	RECOMMENDED	RECOMMENDED	FEASIBLE
CRACK SEALING	RECOMMENDED	RECOMMENDED	FEASIBLE
SPRAY APPLIED PRESERVATION	NOT RECOMMENDED	NOT RECOMMENDED	NOT RECOMMENDED
REJUVINATOR /FOG	NOT RECOMMENDED	NOT RECOMMENDED	NOT RECOMMENDED
SAND SEAL	FEASIBLE	FEASIBLE	NOT RECOMMENDED
SCRUB SEAL	FEASIBLE	FEASIBLE	NOT RECOMMENDED
SLURRY SEAL	FEASIBLE	FEASIBLE	NOT RECOMMENDED
CHIP SEAL	RECOMMENDED	FEASIBLE	FEASIBLE
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CAPE SEAL	RECOMMENDED	FEASIBLE	FEASIBLE
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HIR	RECOMMENDED	RECOMMENDED	FEASIBLE
HMA OVERLAY (Less Than 2")	FEASIBLE	FEASIBLE	FEASIBLE
BWC (Less Than 1")	RECOMMENDED	FEASIBLE	FEASIBLE
ULTRA THIN HMA (0.5" - 1.0")	FEASIBLE	NOT RECOMMENDED	NOT RECOMMENDED

TRAVERSE CRACKING

Transverse cracking is a type of asphalt pavement damage that occurs when cracks run perpendicular to the pavement's center line.

Transverse cracking can be caused by many factors, including:

- When hot asphalt mix that is still wet meets cold air, resulting in thermal cracking.
- A higher content of lime and fly ash, which increases drying shrinkage deformation and temperature shrinkage deformation and can lead to more transverse cracks.
- The type of base used, also affecting transverse crack spacing.

Transverse cracking in asphalt can be prevented by:

- Hiring a reputable contractor to install asphalt correctly, including ensuring proper compaction and thickness of the layers.
- Regularly inspecting your asphalt for cracks and other damage and address them before they spread. This includes resealing, crack mending and pothole repairs.
- Applying a sealcoat every two to three years to protect the asphalt from UV rays, water and other elements.
- Ensuring your pavement has proper drainage to prevent standing water, which can weaken the subbase and lead to cracking.
- Sweeping and power washing your pavement to prevent debris and water from seeping into cracks.
- Distributing weight evenly on all asphalt surfaces.

FLEXIBLE PAVEMENT PRESERVATION TREATMENT MIX

SEVERITY	**LOW** (Very Mild)	**MEDIUM** (Noticable, But Not Extensive)	**HIGH** (Extensive In Most Locations)
CRACK FILLING	RECOMMENDED	RECOMMENDED	FEASIBLE
CRACK SEALING	RECOMMENDED	RECOMMENDED	FEASIBLE
SPRAY APPLIED PRESERVATION	NOT RECOMMENDED	NOT RECOMMENDED	NOT RECOMMENDED
REJUVINATOR /FOG	NOT RECOMMENDED	NOT RECOMMENDED	NOT RECOMMENDED
SAND SEAL	RECOMMENDED	RECOMMENDED	NOT RECOMMENDED
SCRUB SEAL	RECOMMENDED	RECOMMENDED	NOT RECOMMENDED
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ULTRA THIN HMA (0.5" - 1.0")	FEASIBLE	NOT RECOMMENDED	NOT RECOMMENDED

LONGITUDINAL CRACKING

Longitudinal cracking in asphalt is a type of pavement distress that occurs when cracks run parallel to the centerline of the pavement. Longitudinal cracking can allow moisture to infiltrate the pavement, making it rougher.

Longitudinal cracks can be caused by a number of factors, including:

- Poorly constructed paving lane joints.
- Thermal shrinkage due to low temperatures or hardening of the asphalt.
- Inadequate support.
- Reflection from underlying layers.
- Uneven settlement of the foundation.
- Overweight loads.
- Frost heaving.
- Load-related stress.

To prevent longitudinal cracking, you can:

- Avoid heavy traffic and excessive weight on the pavement, especially during extreme temperature fluctuations.
- Seal the cracks every one to two years.
- Sealcoat your pavement every two to three years to protect it from water damage and UV rays.
- Combine geogrid reinforcement and lime treatment.

REFLECTIVE CRACKING

Reflective cracking is a type of asphalt pavement failure that occurs when cracks appear in a flexible overlay over an existing crack or joint in the underlying surface, which can lead to a number of problems.

Reflective cracking can be caused by many factors, including:

- The concrete slab joints expand and contract due to temperature changes.
- Large traffic loads exacerbate reflective cracking.
- The asphalt ages and hardens over time.
- The type of road infrastructure increases the occurrence of reflective cracking.

There are several ways to prevent reflective cracking in asphalt, including:

- Thicker overlays help dissipate stresses and reduce the severity of cracks.
- Rubblizing concrete pavement and overlaying it with asphalt pavement is a cost-effective way to reduce reflective cracking.
- Fractured slab processes reduce or eliminate the effective length of the original slab to prevent movement of the concrete layer.
- Crack sealing can prevent moisture from entering and prolong the life of the pavement.
- A saw-cut can be made to form a clean opening which can be sealed to minimize damage.
- Geogrids, geocomposites and geogrid composites can delay the onset of reflective cracking and reduce the magnitude and severity of cracks.
- In warm climates, incorporating fabric under a chip seal can improve the life of a chip seal by 50-70%.

RUTTING AND SHOVING

Rutting and shoving are types of pavement distress that can occur in asphalt roads and bridge decks.

Rutting is the formation of valleys or ruts in the asphalt surface and can be caused by insufficient pavement thickness, lack of compaction or weak asphalt mixtures. Ruts can fill with water, which can cause vehicles to hydroplane.

Shoving is the formation of ripples or small mounds in the asphalt surface. Shoving is also known as wash-boarding. Shoving can be caused by excess asphalt, too much fine aggregate, rounded aggregate, too soft an asphalt or a weak granular base. Shoving often occurs at intersections and highway off-ramps.

Rutting and shoving in asphalt can be prevented by:

- The asphalt being compacted properly, which typically involves passing a roller over the asphalt three to four times. The asphalt should be between 175 and 320 degrees Fahrenheit during compaction.
- The materials used for the pavement being strong, stiff, durable and resistant to moisture, temperature and fatigue.
- A polymeric additive being used in the asphalt to help prevent rutting and shoving.
- Increasing the thickness of the structural layers to reduce the intensity of stresses transmitted to the subgrade from the road surface.
- Using a stiffer binder to increase resilience for flexible pavement design.
- Using additional steel to increase resilience for rigid pavement design.

ASPHALT RAVELING

Asphalt raveling is the process by which the top layer of asphalt breaks down, exposing the aggregate materials underneath, such as gravel, sand and crushed stone, and making a road surface rough and pitted. It can also compromise the foundation of the asphalt, making the surface more vulnerable to further deterioration. Raveling is one of the most common issues with driveways and parking lots, but it's also one of the most easily repairable.

Raveling can be caused by a number of factors, including:

- As asphalt ages and hardens, the asphalt binder and fine aggregate wear away, exposing the coarse aggregate.
- If the aggregate becomes more absorbent, the asphalt cement can't bond effectively with it.
- Dirty aggregate can create a barrier between the asphalt and the aggregate.

To prevent raveling, you can:

- Avoid parking on the pavement, especially in the same spot repeatedly.
- Use your driveway instead of parking on the street.
- Remove snow and ice from the pavement as quickly as possible.

OXIDATION

Oxidation is a natural process that starts to occur the moment asphalt is laid. The process starts slowly but continues indefinitely and gradually becomes worse. Asphalt binders are made of organic molecules that react with oxygen in the air. This reaction is similar to how an apple or banana browns when exposed to air. Warm mix asphalt (WMA) has been shown to perform better than hot mix asphalt (HMA) in terms of cracking.

Oxidation has a number of causes, including:

- The rate of oxidation doubles for every 10 degrees Celsius increase in temperature.
- The more oxygen that's available to react with the asphalt, the faster it will oxidize.
- The longer asphalt is exposed to oxygen, the more it will oxidize.
- The sun's ultraviolet (UV) rays break down the asphalt binders, causing them to oxidize.
- Vehicle traffic can also contribute to asphalt oxidation.

Oxidation can be prevented or slowed by:

- Applying a thin protective layer of sealcoating to the asphalt surface to keep oxygen away and protect from UV rays. Sealcoating is most effective when done in the first few years after the asphalt is laid. If your asphalt has already oxidized, sealcoating won't be as effective.
- Sweeping and washing your asphalt regularly to remove debris and maintain its appearance.
- Addressing any cracks in your asphalt as soon as they appear.

FRICTIONAL RESISTANCE

Frictional resistance in asphalt, also known as skid resistance, is caused by the combination of adhesion and hysteresis between a vehicle's tires and the asphalt pavement. Adhesion is the attractive force between the tire rubber and the pavement surface, which occurs in areas of high local pressure. Hysteresis refers to the energy loss that occurs when the tire rubber deforms around the pavement's protuberances and depressions.

Friction is influenced by a number of factors:

- The pavement's texture, the material it's made from and how wet it is.
- The pavement's surface must be safe and comfortable for users, especially at higher speeds.
- The macrotexture of dense graded asphalt concrete (DGAC) is typically between 0.40 and 0.80 mm, while open graded friction course (OGFC) is typically between 0.80 to 1.40 mm.

Frictional resistance can be managed by:

- Using a High Friction Surface Treatment (HFST), which involves applying a layer of aggregate over a polymer resin binder.

UNSEALED/OPEN PAVEMENT

Unsealed roads are those that have not been sealed with a surface treatment, like rolled asphalt or chip seal, even though they have been constructed. These usually consist of gravel roads, with loose aggregates that have not been sealed in with surface treatment. In terms of appearance, a sealed parking lot will look brand new since the coating provides a dark black finish to refresh your pavement.

Permeable or open grid paving consists of standard concrete blocks, which have a large percentage of the surface area that is open or penetrable. The open area allows for water to penetrate the paving as opposed to normal paving (clay, concrete asphalt), which assists water running off the paving into stormwater systems.

BLEEDING

Bleeding, also known as flushing, is a condition that occurs when asphalt in a pavement rises to the surface and forms a shiny, black film, which can create a smooth, slippery surface that can lead to hydroplaning.

Bleeding can be caused by a number of factors, including:

- Too much asphalt in the mix, or the wrong type of asphalt.
- Poor construction practices, such as an improperly constructed seal coat or a prime coat that's too heavy.
- Hot weather or traffic compaction can cause the asphalt to fill voids in the pavement and expand onto the surface.

Bleeding can be prevented by:

- Ensuring the asphalt is not too porous.
- Using a well-drained aggregate.
- Incorporating adequate drainage into the pavement design.
- Using polymer-modified or other binders to improve seal coat and surface treatment performance.
- Addressing best-practice factors like traffic loads and environmental conditions.

POTHOLES

Potholes are pot-shaped depressions in asphalt pavement that form when the weight of traffic exceeds the pavement's ability to support it. Pavement in the fatigued area disintegrates rapidly into 1- to 2-inch pieces that are easily dislodged by traffic.

Potholes are usually caused by:

- Water seeps into the soil below the road surface and freezes when temperatures drop, causing the ground to expand and push the pavement up. When the temperatures rise, the ground returns to normal, but the pavement remains raised and creates a gap.
- The weight of vehicles driving over the gap causes the pavement to crack and fall into the hollow space. The more traffic a roadway sees, the more impact the pavement is subject to.

Potholes can be prevented by:

- Seal cracks as soon as you notice them to prevent water from seeping into the asphalt and causing potholes. For small cracks, you can use a liquid cold-pour crack filler or find an asphalt contractor to fix them with a hot-pour rubberized crack filler.
- Reseal your asphalt every one to two years to protect it from sun and heat damage.
- Regularly inspect and maintain your asphalt to spot damage early. You can also clean your driveway or parking lot with a wire or poly street broom to remove dust, leaves and pebbles.
- Overlays are a more intensive treatment that involves constructing a layer of compacted asphalt to seal the surface.
- Reconstruction involves digging up and rebuilding the damaged roadbed.

ROUGHNESS OF RIDE

The International Roughness Index (IRI) is a measure of how rough or smooth a road is, and how it affects the ride quality of a vehicle. The IRI is a mathematical calculation that simulates a vehicle's response to the unevenness of a road's surface. The lower the IRI, the smoother the road.

The IRI is calculated using a profiler, a device that measures the distance between a vehicle and the road surface. The IRI is reported in units of inches per mile (in/mi), meters per kilometer (m/km) or millimeters per meter (mm/m).

Roughness affects vehicle delay costs, fuel consumption and maintenance costs. Studies have shown that smoother roads can lead to better fuel economy.

A rough ride on asphalt can be caused by a number of factors, including:

- Deeper problems in the pavement, such as rutting, upheavals or depressions.
- Traffic loading can cause pavement to deteriorate.
- Weather conditions like rain, snow, frost and storms can contribute to pavement roughness.
- The type of aggregate used in the asphalt mix can affect the surface texture.
- Poor construction techniques can lead to pavement settling and depressions.
- An unstable subgrade can cause pavement to settle and depressions to form.
- Insufficient pavement thickness can lead to problems.
- Improper curing and finishing of concrete can cause disintegration.

The roughness of asphalt can be prevented by:

- Considering pavement design.
- Maintaining and rehabilitating pavement timely.
- Paying attention to test sections.

SURFACE OR SHOULDER DAMAGE

Asphalt roads can experience damage to both the surface and the shoulder wherein the vertical distance between the paved surface and the unpaved shoulder increases. This can happen when the pavement edges erode, and is often caused by inadequate construction. Drop-offs can be dangerous for drivers, especially smaller vehicles.

Asphalt can crack in a number of ways, including linear cracks that run parallel to the laydown direction, transverse cracks that run perpendicular and block cracks that look like large rectangles. Cracks can be caused by a number of things, including poor joint structure, heavy traffic and temperature cycles.

Asphalt can also experience distortion, disintegration, skidding hazards and surface treatment distresses.

Some common causes of asphalt damage include:

- Poor drainage.
- Heavy vehicles driving too close to the edge of the road.
- Climate influences.
- Materials quality problems.
- Construction deficiencies.
- Utility cuts.

Some prevention of surface or shoulder damage includes:

- To protect and help support the edges of the new pavement, we recommend that you install stone, gravel or topsoil around its perimeter.
- Avoid leaks or spills of gasoline, fuel oil, lubricants and other petroleum-based products on the pavement.

ADT

ADT can be converted to AADT by applying monthly, day of week, axle factor and change rate. As described above, AADT is the total volume of vehicle travel on a road for a year, divided by 365. ADT is the average number of vehicles traveling through a location during a period shorter than a year.

EXPECTED LIFE

Asphalt can last 15-25 years without maintenance, but with proper care, it can last up to 35-50 years. The lifespan of asphalt depends on many factors, including:

- **Maintenance:** Regular maintenance and repairs can extend the life of asphalt.
- **Installation:** Asphalt installed on an existing surface may need to be resurfaced sooner.
- **Usage:** Commercial parking lots may need to be resurfaced more frequently due to higher usage.
- **Weather:** Areas with freeze-thaw cycles or strong sunlight and heat may cause asphalt to deteriorate faster.
- **Soil:** The type of soil underneath the asphalt can affect its lifespan.
- **Truck traffic:** The weight of truck traffic can damage roads.

Tar and chip driveways, which are made of asphalt covered with crushed stone, have a shorter lifespan of 7-10 years.

Crack Sealing

Crack sealing is a pavement maintenance technique that involves the placement of specialized treatment materials into working cracks to prevent water and incompressible particles from entering and deteriorating the pavement structure. Working cracks are defined as those that show significant movement, typically more than 0.1 inches, due to changes in temperature and pavement movement.

Here's a step-by-step explanation of the crack-sealing process:

1. **Crack Preparation:** Cracks must be prepared before sealing, which often involves routing to enlarge the crack into a reservoir and cleaning it of debris and moisture. This can be done with brushes, air compressors, hot air lances or other methods.
2. **Material Selection:** The sealant material used for crack sealing is specifically designed to be elastic and capable of expanding and contracting with the pavement's movement. Common materials include hot-applied rubberized asphalt sealants, silicone and pre-formed compression sealants.
3. **Sealant Application:** The selected sealant is then applied into the crack using specialized equipment such as a melter applicator, which heats the sealant to a liquid state before it is poured into the crack.
4. **Finishing:** After the sealant is applied, it may be tooled or squeegeed to promote good bonding with the crack walls and to create a smooth, level finish with the pavement surface.
5. **Curing:** The sealant must cool and cure before the pavement is reopened to traffic. The time required for this can vary depending on the sealant type and environmental conditions.

The benefits of crack sealing include:

- **Water Infiltration Prevention:** It effectively prevents water from entering the pavement structure, reducing the potential for freeze-thaw damage and sub-base erosion.
- **Extended Pavement Life:** By maintaining the pavement's integrity, crack sealing extends its service life.
- **Cost Savings:** It is more cost-effective to seal existing cracks than to repair more extensive damage after water has entered and weakened the pavement.
- **Maintained Pavement Performance:** Crack sealing helps sustain the pavement's strength and performance by keeping the surface intact.

Crack sealing is considered a critical preventive maintenance activity and is typically performed on cracks that are actively widening and shrinking. It is more specialized than crack filling, as it uses materials designed to bond to the crack edges and stretch as the pavement moves, providing a longer-lasting solution.

Crack Filling

Crack filling is a pavement maintenance practice that involves placing an asphalt emulsion or cutback asphalt material into non-working cracks to substantially reduce water infiltration and reinforce the adjacent pavement. Non-working cracks are typically horizontal or vertical movements of less than 0.1 inches.

Here's how crack filling is typically done:

1. **Crack Preparation:** Before filling, cracks must be prepared by removing any loose material with a wire brush, air compressor or hot air lance. The cracks may also be routed to create a uniform reservoir for the filler material.
2. **Material Selection:** The choice of crack filler material depends on the type of pavement, climate and the nature of the crack. Common materials include asphalt emulsions, asphalt cutbacks and rubberized asphalt.
3. **Filling the Crack:** The selected crack filler is then placed into and over the crack using various tools such as a pour pot, a wand with a nozzle or a crack-filling machine.
4. **Squeegeeing:** After the filler is applied, it may be squeegeed to promote bonding with the pavement surface and to create a smooth, level seal.
5. **Curing:** The filler material must cure before the pavement can be opened to traffic. The curing time can vary based on the material used and the environmental conditions.

The benefits of crack filling include:

- **Water Infiltration Prevention:** By sealing the cracks, water is prevented from penetrating into the sub-base, reducing the risk of freeze-thaw damage and potholes.
- **Pavement Life Extension:** Crack filling extends the lifespan of the pavement by slowing deterioration.
- **Cost-Effective:** It is a cost-effective way to maintain pavement and delay more expensive repairs such as overlays or full replacements.
- **Quick Application:** Crack filling can be performed relatively quickly with minimal disruption to traffic.

Crack filling differs from crack sealing primarily in the type of material used and the size of the crack being treated. Crack sealing typically uses a rubberized material that can expand and contract with the pavement, making it more suitable for working cracks. Crack filling, on the other hand, is generally used for inactive cracks where less movement is expected.

Hot In-Place Recycling

Hot In-Place Recycling (HIR) is a pavement rehabilitation method that involves the treatment and reuse of the existing asphalt pavement material, conducted on-site and in-place. HIR renews the pavement by heating, softening and rejuvenating the asphalt surface layer, which can then be remixed, reshaped and compacted to create a restored pavement structure.

The HIR process includes the following steps:

1. **Heating:** Specialized equipment heats the existing asphalt pavement to a temperature high enough (usually around 300°F) to make it pliable and workable without causing damage to the asphalt binder.
2. **Milling or Scarifying:** The top layer of the heated pavement is mechanically removed (milled) or scarified to a specified depth, typically one to four inches.
3. **Rejuvenating:** A rejuvenating agent is added to the milled material to restore some of the properties lost due to oxidation and aging of the asphalt binder.
4. **Mixing:** The reclaimed asphalt is mixed to ensure a uniform coating of the rejuvenating agent and to achieve the desired consistency and gradation.
5. **Laying:** The recycled mixture is then laid back down onto the pavement using a paver.
6. **Compacting:** The mixture is compacted using rollers to produce a dense, smooth pavement layer.
7. **Applying an Overlay (if required):** In some HIR processes, after the recycled layer has been placed and compacted, an additional new hot mix asphalt overlay may be applied to provide additional structural capacity and a smooth driving surface.

The benefits of HIR include:

- **Environmental Stewardship:** HIR reduces the need for new materials and the associated environmental impacts of extraction, production and transportation.
- **Cost-Effectiveness:** By reusing existing pavement materials, HIR can be more cost-effective than conventional remove-and-replace methods.
- **Speed of Construction:** HIR can be performed quickly, minimizing traffic disruptions and road closures.
- **Energy Efficiency:** The HIR process uses less energy compared to producing new hot mix asphalt.
- **Enhanced Pavement Performance:** The process can improve pavement performance by correcting ruts, cracks and other surface distresses, restoring flexibility and improving skid resistance.

HIR is suitable for pavements where the distress is confined to the upper portion of the pavement structure. The process is not recommended for pavements with severe structural deficiencies, poor subgrade conditions or where full-depth reconstruction is needed.

Cold In-Place Recycling

Cold In-Place Recycling (CIR) is a method of reconstructing and rehabilitating existing pavement by recycling the existing asphalt pavement without applying heat. CIR can be applied to pavements that are structurally sound but have surface distresses. It is a cost-effective and sustainable approach to road maintenance, which conserves resources and reduces the environmental impact associated with traditional pavement reconstruction methods.

The CIR process typically involves the following steps:

1. **Milling:** The top layer of the existing pavement is milled to a predetermined depth, usually 2 to 5 inches, using a cold planing machine.
2. **Crushing and Screening:** The milled asphalt material, known as Reclaimed Asphalt Pavement (RAP), is crushed and screened to achieve a consistent size and gradation.
3. **Mixing:** The RAP is mixed with a recycling agent, such as an emulsified or foamed asphalt binder, and possibly other additives, such as lime or cement. This mixture may also include virgin aggregate if needed to enhance the mix properties.
4. **Laying Down:** The recycled mixture is laid down on the prepared roadway base using a paving machine.
5. **Compacting:** The placed material is then compacted to achieve the desired density and to ensure proper bonding with the underlying layers.
6. **Curing:** The compacted layer is allowed to cure. During this period, the recycling agent reacts with the RAP, and the mixture gains strength.
7. **Surface Treatment:** A new surface course, such as an overlay of Hot Mix Asphalt (HMA), is often applied over the recycled layer to provide a smooth driving surface and to protect the recycled pavement.

The benefits of CIR include:

- **Cost Savings:** CIR reduces the need for new materials, thereby lowering construction costs.
- **Environmentally Friendly:** The process reduces the carbon footprint by recycling existing materials and using less energy compared to traditional asphalt production.
- **Reduced Construction Time:** CIR can be completed more quickly than full pavement reconstruction, minimizing traffic disruption.
- **Enhanced Pavement Properties:** The process can improve the overall quality and performance of the pavement by correcting distresses and restoring structural integrity.
- **Conservation of Resources:** CIR uses existing pavement materials, conserving natural resources and reducing the need for quarrying and hauling new materials.

CIR is most effective when applied to pavements with surface distress, such as cracking and raveling, but with a strong underlying base. It is not suitable for pavements with significant structural failures or poor subgrade conditions.

Cape Seal

A cape seal is a two-step pavement preservation process that combines two surface treatments: a chip seal followed by a slurry seal or microsurfacing. This method provides the benefits of both treatments, resulting in a smoother surface than a chip seal alone and adding structural integrity to the pavement system.

Here's a step-by-step explanation of the cape seal process:

1. **Chip Seal Application:** The first step is applying a chip seal, which involves spraying a hot liquid asphalt emulsion onto the existing pavement surface and then immediately covering it with a layer of uniformly sized aggregate chips. The chips are then compacted into the emulsion to form an interlocked adhesive layer.
2. **Curing of Chip Seal:** The chip seal layer must cure for typically one to two weeks. This allows the emulsion to set properly and the aggregate to become firmly embedded in the binder. During this period, any loose chips are swept off the surface.
3. **Slurry Seal or Microsurfacing Application:** Once the chip seal has properly cured, a slurry seal or microsurfacing layer is applied over the top. This second step involves spreading a mixture of fine aggregates, asphalt emulsion, water and additives over the surface. This layer fills any remaining voids and provides a smooth, durable wearing surface.
4. **Curing of Final Surface:** The slurry seal or microsurfacing layer is then allowed to cure. The curing time is typically shorter than for the chip seal, often just a few hours.

The benefits of a cape seal include:

- **Improved Surface Texture:** The final slurry or microsurfacing layer provides a smoother surface than the chip seal alone, enhancing ride quality.
- **Enhanced Durability:** The combination of treatments results in a more durable surface that can better resist the effects of weathering and traffic.
- **Sealing Cracks:** The cape seal process seals cracks in the pavement, reducing water infiltration that can cause further damage.
- **Cost-Effectiveness:** Cape seals are more cost-effective than reconstructing or resurfacing with hot mix asphalt.
- **Extended Pavement Life:** By combining treatments, cape seals can significantly extend the life of pavement surfaces.

Cape seals are particularly effective on pavements with moderate to severe distress or where a chip seal alone would not provide a sufficiently smooth surface. They are suitable for both urban and rural roads, and the double-layer system is excellent for addressing issues like raveling, oxidation and loss of surface texture.

Microsurfacing

The term “micro seal” is likely a shorthand or variation for “microsurfacing,” a common pavement preservation technique. Microsurfacing is a more advanced form of slurry seal that uses a mixture of polymer-modified asphalt emulsion, graded aggregate, mineral filler, water and other additives. It is applied to existing road surfaces to create a new wearing surface and to address a variety of surface imperfections.

Here’s a step-by-step process of microsurfacing:

1. **Surface Preparation:** The existing pavement is cleaned to remove debris and loose particles to ensure the microsurfacing material adheres properly.
2. **Mixing:** Microsurfacing material is mixed on-site in specialized equipment known as a microsurfacing mixing machine. The mix includes a polymer-modified asphalt emulsion, which provides enhanced performance characteristics compared to traditional slurry seals.
3. **Application:** The mixed microsurfacing material is spread onto the pavement surface using a specialized spreader box attached to the back of a truck. The spreader box ensures an even application at the specified thickness.
4. **Setting and Curing:** Microsurfacing sets and cures quicker than traditional slurry seals due to the use of fast-setting polymers. This allows for a shorter period before the roadway can be reopened to traffic.
5. **Traffic Ready:** Typically, microsurfacing can accommodate traffic within a couple of hours after application, which minimizes disruption and road closure time.

The benefits of microsurfacing include:

- **Rutting and Raveling Reduction:** It can fill wheel ruts and prevent the loss of aggregate (raveling).
- **Skid Resistance:** The aggregate used in microsurfacing provides a skid-resistant surface that improves safety.
- **Quick Traffic Return:** Due to its rapid setting time, microsurfacing allows roads to return to service faster compared to other treatments.
- **Versatility:** It can be applied to various pavement types, including high-traffic roadways, residential streets and airport runways.
- **Cost-Effectiveness:** As a maintenance treatment, microsurfacing is less expensive than more extensive repairs and can extend the life of the pavement.
- **Weather and Aging Protection:** It shields the pavement from the effects of weather and delays the aging process of the asphalt binder.

Microsurfacing is suitable for addressing surface-level pavement issues such as oxidation, loss of friction and minor rutting. It is not intended to repair structural damage or to correct significant base failures.

High-Density Mineral Bond

High-Density Mineral Bond (HDMB) is a proprietary, high-performance surface treatment for asphalt and concrete pavements. It is a type of enhanced seal coat that uses a specially formulated polymer-modified emulsion mixed with fine aggregates and other additives to create a dense, durable wearing surface. HDMB is designed to penetrate the existing surface and fill small cracks and voids, forming a strong bond that restores and protects the pavement.

Here are the steps typically involved in the application of HDMB:

1. **Surface Preparation:** Similar to other surface treatments, the pavement is thoroughly cleaned to remove debris, dirt and loose particles to ensure proper bonding of the HDMB material.
2. **Application:** HDMB is applied to the pavement surface using specialized equipment. The application rate is carefully controlled to achieve the desired density and coverage.
3. **Curing:** After application, the HDMB requires a curing period. During this time, the moisture in the emulsion evaporates, and the polymer-modified asphalt cures to form a strong, durable bond with the aggregate.
4. **Opening to Traffic:** The road can be opened to traffic once the HDMB has properly cured and set.

The benefits of High Density Mineral Bond include:

- **Improved Skid Resistance:** The fine aggregates embedded in the HDMB provide a skid-resistant surface, improving safety for motorists.
- **Extended Pavement Life:** HDMB protects the pavement from oxidation and weathering, delaying the aging process of the asphalt binder.
- **Surface Restoration:** It fills and seals small cracks and imperfections in the surface, restoring the appearance and integrity of the pavement.
- **Enhanced Durability:** The polymer-modified emulsion offers enhanced durability compared to traditional seal coats, resisting wear and tear from traffic and environmental factors.
- **Cost-Effective Maintenance:** HDMB can be a cost-effective option for extending the life of pavement without the need for more extensive and costly repairs.

HDMB is generally used on roadways that experience moderate to high traffic volumes and is suitable for both preventive maintenance and corrective applications. It is also used to address specific pavement conditions such as raveling, loss of friction and minor surface irregularities. It is not intended to correct structural deficiencies or significant pavement failures.

Slurry Seal

Slurry seal is a pavement preservation technique that combines asphalt emulsion, fine aggregate (typically sand) and water, sometimes including mineral fillers or additives. It is applied as a homogeneous mixture over existing pavement surfaces to extend their life. The mixture is produced in specially designed trucks or mixing units and then evenly spread across the surface using a squeegee or spreader box attached to the back of a truck.

Here's a step-by-step explanation of the slurry seal process:

1. **Mix Preparation:** Slurry seal is mixed on-site or near the application area. The mix design is carefully chosen based on the existing pavement conditions and the performance requirements.
2. **Surface Cleaning:** Prior to application, the pavement surface is thoroughly cleaned to remove debris and dust to ensure proper adhesion of the slurry seal.
3. **Application:** The slurry seal is applied uniformly to the pavement surface using the spreader box. The thickness of the application is typically equal to the largest aggregate particle in the mix.
4. **Curing:** After application, the slurry seal needs time to cure. During curing, water in the slurry evaporates, leaving behind the asphalt binder, which then hardens.
5. **Opening to Traffic:** Once cured, the slurry seal provides a new, durable surface layer. The pavement can be reopened to traffic once the slurry seal is sufficiently set, which usually takes a few hours.

The benefits of slurry seal include:

- **Crack Sealing:** Slurry seal fills and seals cracks in the pavement, preventing water from penetrating and causing further deterioration.
- **Restored Surface Texture:** It provides a new, skid-resistant surface that enhances safety and ride quality.
- **Protection from Oxidation:** The new surface layer protects the underlying asphalt from oxidation caused by exposure to oxygen and UV rays.
- **Cost-Effective:** It is a cost-effective maintenance method that extends the life of the pavement without the need for more expensive repairs.
- **Aesthetic Improvement:** Slurry seal gives the pavement a uniform, black appearance, similar to new asphalt.
- **Quick Application:** The process is relatively quick, and the disruption to traffic is usually minimal compared to other resurfacing methods.

Slurry seal is suitable for low to medium volume roads, residential streets, parking lots and airports. It is not intended to correct structural issues but is used as a preventive maintenance technique to address surface aging and minor raveling and to seal the surface against the ingress of water.

Scrub Seal

Scrub seal is a pavement preservation technique that involves the application of a modified asphalt emulsion to the road surface, followed by the application of an aggregate cover. The uniqueness of a scrub seal compared to other seals is the use of a scrub broom (a broom with flexible bristles) to work the emulsion into the cracks and crevices of the pavement surface before the aggregate is applied. This process enhances the seal's ability to fill cracks and ensures a better bond between the pavement and the seal.

Here's a step-by-step explanation of the scrub seal process:

1. **Surface Preparation:** The existing pavement is cleaned to remove debris, dust and other materials that may prevent good adhesion.
2. **Emulsion Application:** A modified asphalt emulsion is applied to the road surface using a distributor truck. The type of asphalt emulsion is selected based on existing pavement conditions and climate.
3. **Scrubbing:** Immediately after the emulsion is applied, a scrub broom is used to work the emulsion into the pavement surface. The broom helps ensure that the emulsion penetrates into the cracks and voids, providing a better seal.
4. **Aggregate Application:** While the emulsion is still tacky, aggregate is spread over the surface. The aggregate type is chosen based on compatibility with the emulsion and desired surface characteristics.
5. **Rolling:** After the aggregate application, the surface is rolled with pneumatic tire rollers to embed the aggregate into the emulsion and to remove excess loose aggregate.
6. **Curing:** The scrub seal must be allowed to cure properly. This process involves the evaporation of water from the emulsion, leaving the residual asphalt to bind the aggregate to the pavement.
7. **Sweeping:** Once the curing is complete, any loose aggregate is swept from the surface.

The benefits of scrub seal include:

- **Crack Sealing:** It effectively seals existing pavement cracks and prevents water infiltration, which can cause further pavement damage.
- **Improved Traction:** The new aggregate surface provides enhanced skid resistance and improved safety.
- **Cost-Effective:** As a pavement maintenance technique, scrub seals are less expensive than more extensive repairs or overlays.
- **Extended Pavement Life:** By providing a protective layer, scrub seals can extend the service life of the pavement.
- **Correcting Minor Surface Irregularities:** Scrub seals can help to fill small surface imperfections and improve ride quality.

Scrub seals are typically used on aging asphalt surfaces that require sealing and minor surface correction. They are effective for roads with moderate to low traffic volumes, and the process is relatively quick, minimizing traffic disruption.

Sand Seal

A sand seal is a pavement preservation technique that involves the application of a quick-setting asphalt emulsion to the pavement surface, followed by a layer of fine aggregates, such as sand. This process provides a new wearing surface and can be used to fill small cracks and voids, improve skid resistance and protect the pavement structure by sealing the surface from the ingress of water and the effects of oxidation.

The process typically follows these steps:

1. **Surface Cleaning:** The existing pavement surface is cleaned to remove any dust, debris and loose material to ensure proper bonding of the asphalt emulsion.
2. **Asphalt Emulsion Application:** A quick-setting asphalt emulsion is sprayed onto the pavement surface using specialized equipment. The type of emulsion used is selected based on the existing pavement conditions and the desired performance characteristics.
3. **Sand Spreading:** Immediately after the emulsion is applied, clean sand is spread over the surface. The sand should be of a specified gradation that allows it to embed into the emulsion without completely obscuring it.
4. **Rolling:** Once the sand is applied, it is rolled with pneumatic tire rollers to ensure good contact and adhesion between the sand and the asphalt emulsion.
5. **Excess Sand Removal:** After the emulsion has cured, any excess sand is removed from the surface, typically with a mechanical broom or air blower.

The benefits of a sand seal include:

- **Improved Surface Texture:** The fine aggregate provides a textured surface that can improve skid resistance and traction for vehicles.
- **Pavement Preservation:** The seal serves as a barrier against moisture and sunlight, helping to slow down the oxidation of the asphalt binder.
- **Filling Minor Cracks:** The combination of asphalt emulsion and sand can penetrate and fill small cracks in the pavement surface.
- **Cost-Effectiveness:** Sand seals are relatively inexpensive compared to other surface treatments and can be a cost-effective method for maintaining low-volume roads.

Sand seals are typically used on low-traffic roads or as a part of a multi-layer surface treatment in combination with other seals. It is important to apply sand seals during warm, dry weather conditions to ensure proper curing of the asphalt emulsion.

Mastic Seal

Mastic seal is a type of thick, viscous asphalt material that is used to repair larger cracks, potholes and other surface distresses in both asphalt and concrete pavements. It is a blend of asphalt binder, fibers and aggregates that form a flexible and adhesive compound capable of filling and sealing irregularities in pavement surfaces.

The characteristics and benefits of mastic seal include:

- **Versatility:** Mastic seal is suitable for a wide range of repair jobs, from small to large, distressed areas, including utility cuts.
- **Durability:** The material is designed to be highly durable and flexible, which allows it to accommodate the movements of the pavement and the changes in temperature without cracking.
- **Adhesion:** Mastic seal adheres well to the pavement surface, providing a strong bond that helps to prevent water infiltration and further deterioration of the pavement.
- **Load Bearing:** It can withstand heavy traffic loads, making it appropriate for use in both low and high-volume traffic areas.
- **Ease of Application:** Mastic seal can be applied relatively quickly and does not require the removal of the existing pavement.
- **Smooth Transition:** When applied properly, mastic seal creates a smooth transition between the existing pavement and the repair area, which can improve ride quality.
- **Waterproofing:** By sealing cracks and joints, mastic seal helps to prevent water infiltration, which is a leading cause of pavement deterioration.
- **Longevity:** Repairs made with mastic seal tend to last longer than those made with more traditional patching materials, leading to longer intervals between maintenance.

Mastic seal is typically applied using specialized equipment that heats the material to the required application temperature. The hot mastic is then poured into the prepared area and leveled to match the surrounding pavement surface. It is a highly effective pavement preservation method for addressing intermediate to large-scale distresses that are beyond the capabilities of crack sealants but not yet severe enough to warrant complete pavement replacement.

Fog Seal

Fog seal is a light application of a diluted, chemically-stabilized asphalt emulsion applied to the surface of aging asphalt pavements. Its primary purpose is to seal and enrich the surface, helping to extend the pavement's life by addressing issues such as minor cracking, pitting and raveling, and reducing the permeability of the asphalt surface. Fog seals are particularly useful for combating surface distress, protecting the pavement from further damage and enhancing the appearance by darkening the surface.

Here's an explanation of the benefits and characteristics of fog seals:

1. **Surface Enrichment:** Fog seals replenish the binder in the asphalt surface, which may have been lost due to oxidation and weathering.
2. **Sealing Minor Cracks:** While not a replacement for a proper crack-sealing program, fog seals can reduce the infiltration of water by sealing small, non-working cracks.
3. **Reducing Raveling:** Fog seals can help bind the aggregate particles together, thereby reducing raveling, which is the dislodgement of aggregate from the pavement.
4. **Reducing Permeability:** By filling surface voids, fog seals can reduce water infiltration, which is a primary cause of pavement deterioration.
5. **Enhancing Appearance:** A fog seal application darkens the asphalt surface, which can improve the visibility of pavement markings and the overall look of the pavement.
6. **Preventive Maintenance:** As part of a preventive maintenance program, fog seals are cost-effective treatments for extending pavement life.
7. **Surface Friction Consideration:** After application, fog seals can temporarily reduce surface friction. Caution should be used when applying fog seals to high-traffic areas.
8. **Non-Trafficked Surface Application:** Fog seals are recommended for non-trafficked surfaces such as shoulders and areas around general aviation airports to enhance aggregate retention and minimize potential sources of Foreign Object Debris (FOD).

It's important to note that fog seals do not improve fuel resistance, and they should not be applied to pavements that lack surface permeability. They are not designed to soften the underlying asphalt but to act as a sacrificial layer to protect the underlying surface.

Chip Seal

Chip seal, also known as tar and chip, is a pavement surface treatment that combines one or more layers of asphalt with one or more layers of fine aggregate. It is a cost-effective way to provide a new driving surface that will protect the underlying pavement from moisture and provide a high level of skid resistance. Chip seals are used on a wide variety of pavements, from rural roads to residential streets.

Here's the step-by-step process of chip seal application and its key characteristics:

1. **Cleaning:** The existing pavement surface is thoroughly swept or blown clean to remove debris and ensure proper adhesion of the asphalt binder.
2. **Binder Application:** A layer of asphalt binder (usually emulsified asphalt) is applied to the pavement surface. The type and grade of asphalt are chosen based on traffic levels, climate and the condition of the existing pavement.
3. **Aggregate Spreading:** Immediately following the binder application, clean, uniformly graded aggregate (chips) is evenly spread over the asphalt binder. The size of the aggregate is typically chosen based on the desired texture and the amount of traffic.
4. **Rolling:** Once the aggregate is applied, it is compacted into the binder with rubber-tired rollers to ensure good contact and embedment. This process also helps to remove excess loose chips.
5. **Curing Time:** After rolling, the chip seal needs time to cure. During this period, vehicles should either be kept off the surface or speed limits should be reduced to minimize the dislodging of chips.
6. **Excess Chip Removal:** After the binder has cured, any loose chips are swept away from the surface. This may be done a few days after the initial application to allow any loose chips to come free from the surface.

The benefits of chip seals include:

- **Sealing Cracks and Protecting Pavement:** Chip seals provide a barrier that seals small cracks in the existing pavement and protects it from the effects of oxidation and weathering.
- **Improved Skid Resistance:** The aggregate surface layer increases traction, providing a safer driving experience.
- **Cost-Efficient:** Chip sealing is a relatively low-cost alternative to traditional hot mix asphalt overlays.
- **Quick Application and Cure Time:** This treatment has a faster application and cure time compared to hot mix asphalt, which means roads can be opened to traffic sooner.
- **Aesthetic Improvement:** Chip seals can enhance the appearance of the pavement with a more textured, consistent look.

It's important to note that chip seals are most effective when applied to pavements in good condition with only minor distresses. They are not designed to add structural strength but rather to extend the life of the pavement by protecting the surface.

Hot Mix Asphalt Overlay

A hot mix asphalt (HMA) overlay is a road maintenance technique that involves the placement of a new layer of hot mix asphalt over an existing paved surface, such as a deteriorating roadway or airport runway. This new layer, which can vary in thickness, is intended to extend the life of the pavement by providing a new, smooth and durable surface.

Hot mix asphalt is a mixture of aggregate (stone, sand or gravel) bound together by asphalt cement, a product of crude oil. HMA overlays are applied hot and compacted to form a solid, dense surface. The process of creating an HMA overlay typically includes the following steps:

1. **Preparation of the Existing Pavement Surface:** The existing surface is cleaned, and any necessary repairs are made. This might include patching potholes, fixing cracks and ensuring a proper profile through milling if required.
2. **Application of Tack Coat:** A tack coat, a light application of asphalt emulsion, is applied to the existing surface to promote bonding between the old and new pavements.
3. **Laying the HMA Overlay:** The hot mix asphalt is transported to the site in trucks, laid down by a paver and then compacted using rollers. The compaction process is essential to ensure that the overlay is fully compacted, has minimal air voids and achieves maximum density.
4. **Cooling:** After compaction, the new HMA overlay is allowed to cool to an ambient temperature before being opened to traffic.

The thickness of an HMA overlay will depend on the existing pavement condition and the expected future traffic loads. Thin HMA overlays (typically 1.5 inches or less) are often used as a preventative maintenance measure or to improve ride quality, while thicker overlays may be used to add structural capacity to a pavement.

HMA overlays are a popular choice for pavement rehabilitation due to their ability to be quickly constructed with minimal traffic disruption and their compatibility with a wide range of temperatures and loading conditions.

A Bonded Wearing Course

A Bonded Wearing Course (BWC) is a high-performance, thin overlay that combines a polymer-modified asphalt emulsion with high-quality, gap-graded aggregate. This pavement preservation method is applied to existing pavement surfaces to provide a new, durable, skid-resistant wearing surface. It's designed to seal the existing pavement from water and air intrusion, improve the ride quality and extend the service life of the road.

The BWC process typically involves the following steps:

1. **Surface Preparation:** The existing pavement is cleaned to remove any dirt, debris or loose particles to ensure a strong bond with the overlay.
2. **Tack Coat Application:** A tack coat of polymer-modified asphalt emulsion is applied to the pavement surface to enhance the bond between the old and new layers.
3. **Aggregate Application:** Immediately after the tack coat application, a layer of gap-graded aggregate is placed on top of the emulsion. The aggregate is chosen for its cleanliness, angularity and durability.
4. **Compaction:** The aggregate is then compacted into the emulsion using pneumatic or vibratory rollers to ensure proper embedment and to achieve a dense, interlocked wearing surface.
5. **Curing:** The newly applied BWC must cure properly before being opened to traffic. The curing time depends on factors such as temperature, humidity and the type of emulsion used.

The benefits of a Bonded Wearing Course include:

- **Improved Skid Resistance:** The gap-graded aggregate provides excellent skid resistance, enhancing roadway safety.
- **Rutting and Reflective Cracking Resistance:** The polymer-modified emulsion and gap-graded aggregate create a flexible layer that can resist rutting and slow the propagation of reflective cracking.
- **Waterproofing:** BWC seals the existing pavement surface, protecting the underlying layers from water infiltration and associated damage.
- **Noise Reduction:** The open texture of the aggregate can lead to reduced tire-pavement noise.
- **Quick Traffic Return:** BWC application allows for a relatively quick return to service, minimizing disruption to traffic.
- **Long Service Life:** When properly applied, a Bonded Wearing Course can significantly extend the life of the pavement.

BWC is appropriate for both asphalt and concrete pavements and is often used on high-volume roads and highways due to its durability and performance benefits. It is a cost-effective solution for treating surface distress and improving ride quality without the need for a thicker traditional hot mix asphalt overlay.



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