A Guide to Trail Surfaces for Historic Sites

Paths, walks, and trails are the means by which visitors access and experience historic sites and natural areas. The visual appearance of circulation systems within historic sites can affect their character as well as the visitor experience. They are a necessary intrusion, but they can and should be designed as an asset that blends seamlessly into their surroundings. Inappropriate surface materials, poor alignments, and deferred maintenance of walks and trails can detract from historic and natural settings and are to be avoided in the design and management of circulation systems.

This guide provides information to support informed decision-making when planning for and designing trails, walks, and paths within historic sites and natural areas. The range of options available is broad and varied; with enough forethought, trails, walks, and paths can be carefully added to almost any site, providing accessibility to all, and contributing to a rewarding visitor experience.

The guide contains four sections. The first summarizes planning considerations related to trail development. The second presents guidelines for the design and construction of the trail types discussed herein that are appropriate for consideration within historic and natural sites. The third section is an at-a-glance table of trail surfaces appropriate for use within historic settings that indicates, for quick comparison, their aesthetic and structural qualities, as well as their installation requirements and maintenance costs. The final section is a glossary of trail surface stabilization products.

Planning Considerations

When planning for the establishment of new trails, or the rehabilitation of existing circulation routes, there are numerous factors important to consider. These factors, including aesthetics, reversibility, anticipated use, site engineering, availability of materials, initial capital costs, maintenance, and universal accessibility, are described below. A discussion of the trail types and surfacing materials to be considered follow these planning considerations.

Aesthetics

Trail surfaces have varied aesthetic traits that can contribute to the overall design concept for a site. Appropriateness to the character of a historic setting is a primary consideration.

Reversibility

Many historic sites endeavor to retain the integrity of resources by avoiding contemporary changes that cannot be removed later. An important planning consideration may be whether the proposed trail is reversible, meaning that it could be installed and removed without impacting historic resources.

Anticipated Use

The needs of anticipated users determine trail designs to a great degree and are a critical planning consideration. Equestrians, wheelchairs, maintenance vehicles, road or mountain bicycles, strollers, and in-line skates can each require different trail surface materials and levels of maintenance. Multiple-use trails attempt to meet the needs of various anticipated users. Sometimes, a single trail surface is not sufficient to accommodate all anticipated users, and several parallel systems need to be considered. In-line skates, for example, require a smooth and hard surface, but the trail shoulder can be designed to accommodate those who prefer to walk on a softer material.

Within historic sites and natural areas, repeat visitors are becoming an important user group. Some repeat visitors are local residents who like to use the trails for walks or recreation. Others may be bringing new visitors to the site. Both groups appreciate the opportunity to experience different trails with a range of difficulty levels and lengths. Providing a range of trails can meet the needs of a broad cross-section of visitors and increase the duration of their stay.

Site Engineering

The underlying soil conditions of the proposed trail play a critical role in the selection of a surfacing material. Engineering properties of soils affect the amount of intervention required to establish a stable base for the surface, while environmental conditions affect the performance of a trail.

Availability of Materials

Costs associated with trail development are affected by the availability of selected surfacing materials. Those that are not native to the trail's region may be prohibitively expensive. Furthermore, some experimental or new materials under consideration for their environmental benefits or sustainability properties may not be readily available on the market, and finding a source for a desired surface material may prove difficult.

Initial Capital Cost

Trail surface costs vary dramatically. The y relate to trail prism excavation, subbase preparation, base placement, and application of the selected trail surface. These costs can range from $1 or $2 per square foot to $12 or $13 per square foot, with some systems such as boardwalks potentially exceeding $100 per foot to construct.

Maintenance

Trail surfaces have an anticipated lifespan that can vary from one to more than twenty-five years. The maintenance regimes associated with different trail surfaces vary from regular inspection to expected follow-up repairs. Some of these repairs need to be administered by skilled professionals.

Universal Accessibility

All sites should offer a universally accessible trail for at least a portion of their system. The federal government has developed guidelines for universally-accessible trails. In particular, surfaces must be measurably firm and stable. The Forest Service Trail Accessibility Guidelines (FSTAG) define a firm surface as one that is not noticeably distorted or compressed by the passage of a device that simulates a person who uses a wheelchair. The FSTAG define a stable surface as one that is not permanently affected by normally-occurring weather conditions but is able to sustain wear and tear produced by normal use between planned maintenance cycles. There are special dispensations for historic sites. For example, where compliance with the Americans with Disabilities Act Accessibility Guidelines (ADAAG) would cause substantial harm to cultural, historic, religious, or significant natural features or characteristics, some exceptions and deviations from technical provisions are often permissible.

Trail Types

Evaluating anticipated use will help determine of the type of trail that is needed. The range of trail types to consider include:

No Trail. Avoid building trails within areas with sensitive natural or archeological resources that could be damaged by visitor access and associated systems.

Backcountry Trail. Backcountry trails are generally narrow hard-packed earth-surfaced routes that are not graded or machine compacted. Only limited interventions such as waterbars are typically associated with backcountry trails. They are used within areas that are remote, are relatively sensitive, have limited existing development, have an anticipated low-impact use, and will be used by a relatively small number of pedestrians.

Pedestrian Trail. Pedestrian trails are more developed than backcountry trails for higher traffic areas. They can be designed to be universally accessible. They are typically wider than backcountry trails and involve additional interventions, such as site grading, subbase installation, and other improvements such as wayfinding and/or interpretive signage. Establishment of this type of trail typically requires the use of construction equipment which can result in a limited degree of disturbance to the trail prism and its surrounding environs.

Unpaved Multi-use Trail. These trails are designed to accommodate moderate use by pedestrians, users of wheeled vehicles such as bicycles that do not require a completely firm and stable surface, and potentially equestrians. This type of trail can accommodate a moderate-use level. Installation of this trail type requires moderate site disturbance, including grading and surfacing, and should thus be designed

to avoid impacting historic resources. It can be made accessible in conformance with Americans with Disabilities Act (ADA) standards using stabilzers.

Paved Multi-use Trail. This trail type is intended to accommodate a wide variety of users and typically involves the highest degree of intervention within a site. It is appropriate for high-use areas, such as the primary visitor interpretive experience or intensive recreation. This trail type should not be established on historic road traces or corridors as their construction requires a high level of disturbance.

Trail Widths

Trail designs should include a proposed or desirable width to accommodate the anticipated user. Trails that are too narrow, uneven, or poorly-drained can result in visitors trampling vegetation, compacting and eroding soil, damaging the surrounding ecosystem or encountering hazards. Wider trails, however, are more costly to construct and maintain and are more obtrusive. Wide trail corridors also have a greater visual impact on historic and natural resources.

Design Guidelines

General Trail Guidelines

Trails within historic settings and natural areas should be considered for their aesthetic and environmental impacts, as well as their affect on historic resources. Surfacing of brown hues are preferrable to blue-colored materials. Petroleum-based surfaces or those that may leach undesirable chemicals into the ground or water systems should also be avoided.

With the exception of backcountry trails, most prisms should be constructed by removing several inches of existing native soil in order to compact the base material to help prevent the possibility of subsurface failure of the trail. After compacting the base, a geotextile filter should be installed. It is necessary to bring in enough aggregate to be sure that the finished compacted surface will not be lower than the surrounding grade. Grading should be used to ensure proper drainage along trails.

Backcountry Trail Guidelines

- Backcountry trails should be designed as as minimal, hard-packed earth-surfaced well-drained, three- to four-foot-wide treadways that require minimal grading and erosion control methods to establish and maintain. Trails should be possible to establish without construction equipment. Backcountry trails are generally not universally accessible.
- Trail slopes should not exceed 15 percent grades.
- They should serve as spurs leading from more developed or major trails.
- Trailhead developments should include minimal signage at intersections with larger trails.
- Stepping stones, stone boxes, or a treadway of large stones should be used when trails pass through wet areas to allow drainage and water to move freely and prevent erosion and compaction. In remote areas, use locally collected stepping stones.

Pedestrian Trail Guidelines

- Pedestrian trails should be designed as minimal, well-drained, earthen-, mulch-, or crushed-stone-surfaced treadways that may require some grading to establish. Excavation for the establishment of a sub-base may be appropriate. These trails can accommodate universal accessibility requirements when stablized crushed-stone surfaces are applied.
- Trail slopes should not exceed 10 percent grades. Cross-slopes should not exceed 2 percent slopes.
- Signage associated with pedestrian trails should be limited to minimal trailheads developments, interpretive information, wayfinding at intersections with other trails.
- Low-profile boardwalks should be used for crossing wet areas.

Unpaved Multi-use Trail Guidelines

- Trails of this type should have a minimum ten-foot-wide firm surface with three-foot-wide soft shoulders to either side to allow passing. These trails should be surfaced with crushed stone, and have shoulders of grass or mulch.
- This type of trail should not be used within historic road traces.
- Trail slopes should not exceed 10 percent grades. Cross-slopes should not exceed 2 percent slopes.
- Signage should be used at trailheads, for orientation, and to post regulations and warnings.

Paved Multi-use Trail Guidelines

- Trails of this type require the greatest intervention into a site and should be avoided within historic settings, particularly in association with historic road traces.
- Trail slopes should not exceed 5 percent grades.

- Surfacing material used on paved multi-use trails will generally be considered for firmness and stability, and will generally be compatible with universal-accessibility requirements.

Universally-Accessible Trail Guidelines

- Universal-accessibility is an important consideration withim historic and natural sites. Primary interpretive elements should be made accessible to all visitors along universally-accessible routes. Other resources can be interpreted through alternative means if trail establishment will negatively affect historic or natural resources.

- Universally-accessible trails should have a firm and stable surface to accommodate usage without degrading the tread surface. Trail runs should not generally exceed a 5 percent grade, with cross slopes that do not exceed a 2 percent grade. Five to ten percent cross slopes are allowable if they occur within the bottom of drainage structures. Trails may reach 8.33 percent for up to 200 feet, 10 percent for thirty feet, 12 percent for ten feet, and 14 percent for five feet within the bottom of a drainage structure.

- Prepared tread surfaces need to be at least thirty-two inches in width within historic sites, although the beaten path width may be narrower. Thirty-two inches is an exception to the ADAAG guideline of thirty-six inches.

- For more information, see the United States Forest Service Trail Accessibility Guidelines (FSTAG).

Guidelines for Adapting Historic Road Traces as Trails

- Historic circulation routes can be incorporated into pedestrian trail systems after the potential impacts of the new system have been assessed for the visual impact of trail on important viewsheds; potential impact on sensitive natural and archeological resources; accessibility issues; and overall interpretive value. Only low-tire-pressure vehicles should be used when working along historic road traces.

- New trails that follow or traverse historic road traces should be designed in such a way as to avoid cutting into the ground in order to preserve archeological resources. Regrading that might damage historic road traces should be avoided. Whenever regrading is necessary, use fill to achieve positive drainage rather than cutting, which will destroy the resource.

- Grading improvements should promote sheet flow rather than concentrated flow into swales, channels, or pipes whenever possible.

- Local materials, such as wood and stone, should be considered for trail-related structures including water bars, stepping stones, signage, fences, steps, treads, stream crossings, stone boxes or treadways crossing marshy areas, retaining walls, trail markers, and shelters. Design these features should be clearly a product of their own time.

Trail Surfaces

Interest in permeability and requirements for accessibility have resulted in the development of new trail surfacing technologies. All trail surfaces vary in cost, environmental impact and maintenance requirements. Trail surface options described here are recommended for historic sites, but should be evaluated in terms of the considerations described above. Trail surface materials also vary in degree of permeability and the use of recycled resources, concerns related to environmental sustainability. The following pages provide a comparative chart of these aspects of trail surface alternatives.

Concrete

Concrete is a durable and readily available material that is firm and stable and meets universal accessibility requirements. It is highly impermeable, however, and has a high run-off rate that can increase the erosive capability of water. Concrete is generally expensive to install, and requires subbase preparation that may cause an unacceptable level of ground disturbance within sensitive archeological areas. Concrete is also a relatively modern material that may be inconsistent with the character of a historic site. There are many treatments that can be applied to concrete , such as added color, tinting, scoring and the use of warm-colored aggregates to render it more visually compatible with a historic setting.

Asphalt

Asphal pavements provide firm and stable surfaces that generally meet universal accessibility standards. Asphalt is durable and readily available. It is not porous, however, and stormwater will run off its surface, contributing to an increase in the volume and speed of stormwater and erosion problems. It is also a petroleum-based product that may leach volatile organic compounds and heavy metals into the ground and water resources. Though cost-effective and highly functional, asphalt is commonly associated with contemporary urban environments and is rarely compatible with historic sites. Treatments that can diminish its visual incompatibility with historic sites include the use of brown-colored aggregate, or the application of a pebble finish top dressing.

Crushed Stone

Crushed stone, particularly warm-hued material, is generally visually compatible with historic settings. Crushed stone makes a good trail surface material when a composed of particles that are irregular and angular and range in size from fine dust to 3/8”. Over time, the particles should bind together in a consolidated slab which is porous yet resistant to water falling on the surface. Crushed stone trails can be easily maintained if properly graded for drainage and placed atop an appropriate subbase. Often, crushed stone trails are not smooth or hard enough to meet the “firm and stable” requirements of a universally-accessible trail. To make the surface harder and smoother, a chemical stabilizing agent can be added so that the fines will set up harder and remain that way for longer periods of time. Underlying soils need to be analyzed to determine the need for geotextiles. If a crusher fine trail surface becomes loose and uncompacted over time, it can often be reshaped, rewetted, and compacted again.

Stabilized Soil

Hard-packed earth is often used as a backcountry trail surface, but is not appropriate for use as a surface for more intensive uses. Soil can be stabilized using chemical binding agents, however, to render it more stable and firm. Hard-packed earth surfacing may be visually compatible within a historic site to interpret older road or path corridors. Stabilization products need to be targeted to site-specific soil conditions, but are worth exploring.

Grass

Mown grass as a trail surface may be compatible with many historic sites. This surface treatement, however, does not meet universal accessibility standards.

Mulch

Although the color and texture of mulch applications are generally compatible with natural and historic areas, and this surface material is relatively inexpensive and reversible, it does not meet universal accesibility standards.

Rubberized Surfaces

Rubberized surfaces are generally not compatible with historic settings, but crumb rubber can be tinted brown, which may help it blend in with its surroundings.

Boardwalks

Boardwalks have a natural appearance cthat omplements historic settings and protects below-ground resources. However, they are expensive to install. Wood is also slippery when wet or icy and may require surface treatments for visitor safety.

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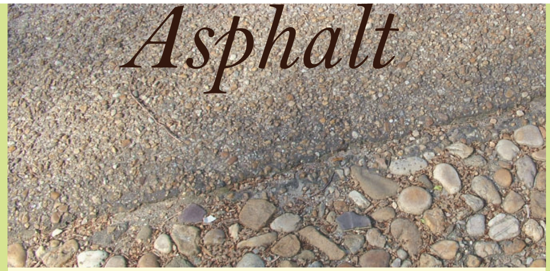
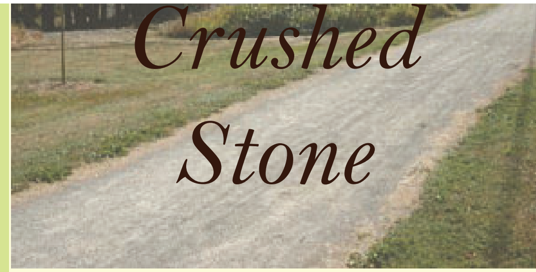
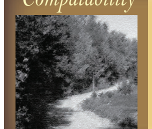




	Concrete	Asphalt	Crushed Stone
Installation	Prepared subbase, geotextile, 6” aggregate base, 4” Portland Cement (with or without aggregate).	Prepared subbase, geotextile, 6” aggregate base, 2” asphalt.	Prepared subbase, geotextile, 6” aggregate base, 2” of < 1/4” crushed stone over base, rolled and compacted.
Maintenance	Periodic inspection for uplift and settlement. Repair as needed.	Pothole patching. Permeable asphalt should be vacuum swept and pressure washed four times a year.	Sweep to fill voids from dislodged fines. Reapply top course every 2-5 years.
Cost	$4.75 per sq. ft. Maintenance est. $ per yr.	$2.75 per sq. ft. $3.50 per sq. ft - permeable asphalt	$2.25 per sq. ft.
Recycling	Decomposed concrete can be used as a loose or bonded aggregate material.	Reground asphalt chips and Glassphalt (asphalt that uses recycled, ground glass as an aggregate) are available.	Recycled decomposed concrete is a possible subsitute for crushed stone.
Permeability	Conventional applications are impermeable. Permeable concrete requires a 12” aggregate base for drainage. Pervious pavers are another option for decreasing run-off.	Conventional applications are impermeable. Permeable asphalt is a porous formula that requires a 12” aggregate base for drainage and has a lower load-bearing capacity.	This surface treatment is permeable.
Accessibility	ADA accessible. Suitable for bicycles and wheelchairs as well as pedestrian uses.	ADA accessible. Suitable for bicycles and wheelchairs as well as pedestrian uses.	ADA-accessible if very fine and compacted. Larger stones are not stable.
Compatability 	*Concrete is associated with contemporary urban environments and can be incompatible and glaring. Tinting, scoring and the use of aggregates can be helpful.*	*Though cost-effective and highly functional, asphalt is commonly associated with contemporary urban environments and is rarely compatible with historic sites.*	*Natural stone is more historically compatible than contemporary concrete and asphalt applications.*

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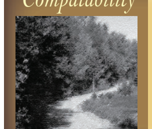
	Stabilized Soil	Grass	Mulch
Installation	Excavate top 2-3" of native material prior to preparing subgrade. Ammend with fine aggregate, underlay geotextile and return and shape/compact topsoil before applying soil stabilizer.	Grade trail base, seed.	Prepared subbase, geotextile, 4" aggregate base, 3" layer mulch raked and shaped, second 3" layer applied after compaction and settlement.
Maintenance	Reapplication of soil stabilizer may be necessary every 2-3 years.	Periodic mowing and possible fertilization required.	Top dress annually. Lasts 1-3 years. Some agricultural byproducts, such as filbert shells, may last as long as 7 years. Rubber mulch does not decompose.
Cost	$2.50 per sq. ft.	$1.00 per sq. ft.	$2.10 per sq. ft.
Recycling	This is not a recycled material, although some stabilization products are made from natural materials such as pine resins.	N/A	Recycled materials such as shredded rubber can be used. Reclaimed agricultural and industrtial byproducts such as wood planer shavings and filbert shells are also available.
Permeability	This is not a permeable surface treatment.	Vegetative surfaces are permeable.	This trail surface application is permeable.
Accessibility	ADA-accessible. Stabilized soil is firm, stable and slip resistant.	Moderately firm and stable but not slip resistant.	**NOT** ADA accessible. Only suitable for pedestrian and equestrian use.
Compatability 	*Stabilized soil is the simplest and least obtrusive of surfacing options and is highly compatibly with historic sites, as it makes use of the native material.*	*Mown grass is associated with 20th-century landscapes but its natural appearance may be compatible.*	*The color and texture of mulch applications are most compatible with natural areas. This treatment is inexpensive and removable but does not provide a stable surface.*

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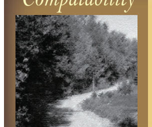
	Resin-based Pavement	Rubberized Surfaces	Boardwalks
Installation	Non-petroleum based resins bind any color aggregate into a hard-surfaced pavement. Installation method is similar to asphalt.	Prepared subbase, geotextile, 6" aggregate base, poured concrete or asphalt base, poured recycled rubber topcoat.	Boardwalk installation involves construction techniques dependent on the material chosen, and their width and length. All boardwalks need curbing, but where 30" or more above grade should also have a handrail.
Maintenance	This is a relatively new and experimental technique. Ongoing studies are determining maintenance demands.	Replace topcoat every 10 years.	Repairs as needed. Periodic washing may be necessary.
Cost	$3.00 per sq. foot - $10.50 per sq. foot (New and proprietary formulas are currently being developed and prices vary).	$10.50 per sq. foot	$20-$200 per sq. foot. Recycled composite lumber is more expensive than pressure-treated wood.
Recycling	The resins material, while environmentally sound, is not made from recycled products.	This pavement material has evolved out of the need to create usable materials from waste tires and is a recycled option.	Boardwalks can be constructed from planks composed of recycled plastic.
Permeability	Both permeable and impermeable applications are available. Formulas like Polypave involve a topcoat and are impermeable. Other kinds of bound aggregate systems are permeable.	No if poured in place and sealed; shredded rubber mulch applications are permeable.	Boardwalks are permeable surfaces and are also effective for protecting wetland areas. They do not interfere with natural drainage patterns.
Accessibility	This treatment is universally accessible. It is firm, stable and slip-resistance.	Yes if poured in place and sealed; no if used in a shredded mulch application. Rubber surface also provides shock absorption which is desired on excercise paths.	Boardwalks provide a universally-accessible surface and also help to steer visitors along a pre-determined route.
Compatability 	*Historic trail surfaces can be made universally accessible with this technique, but it is costly and only feasible in limited applications.*	*Crumb rubber can be tinted brown, which may help this surface to blend in, but otherwise its appearance is very similar to asphalt.*	*The natural wood appearance of boardwalks complement natural settings and protect below-ground resources. However, they are more obstrusive than at-grade trails.*

Glossary of Trail Surface Stabilization Products and Terminology

Bentonite Clay

An absorbent aluminum silicate clay formed from volcanic ash and used in various adhesives, cements, and ceramic fillers.

Binder

An agent that creates uniform consistency, solidification, or cohesion.

Bioenzymes

Bioenzymes create a reaction that stabilizes soil materials. Clay content of 10-15 percent in the aggregate material is necessary for the reaction to take place, and must be amended if necessary. Earth Materials Catalyst (EMC2) is a proprietary formula that contains biocatalytic proteins. It is a trademark of Soil Stabilization Products, Inc. There are several companies that provide similar proprietary enzyme formulas for soil stabilization. Two other names are "Permazyme" and "Eco-Crete."

Chemical Binding

Chemical binding is generally used to form smooth, firm treads from small soil particles on level or low tread grades in reasonably well-drained sites for low and medium displacement uses. Chemical binding tends to be a very specialized approach to trail hardening, and requires specific products and installation techniques. Each application requires independent evaluation to ensure that the product is suitable to accommodate the need of the trail type and proposed surface. Chemical binding is useful for crusher fines, recycled asphalt, and soil.

Flyash

Flyash is a byproduct obtained from the stacks of coal-burning power plants. Flyash contains varying percentages of quicklime depending on the type of coal burned at the plant. Flyash is mixed with fine and coarse aggregates to pave trail surfaces. Unfortunately it does not hold up well with changes in moisture and frost heaves. This product did not noticeably stabilize aggregate materials.

Ground seed hulls

"Stabilizer" is a patented, organic and non-toxic product manufactured from the seed hulls of the Plantago plant. The product is a light brown color and is ground to a very fine texture. This product will not stabilize materials over 3/8 inch in diameter, and the material needs to consist mostly of fines. Water will penetrate the surface of this product. It works best in shade where the surface does not get as dried out. It is very easy to apply. Trails treated with Stabilizer have significantly more vegetation growing through the surface than other options since the surface is not impenetrable and seeds can get established. This product works best in dry climates.

Latex polymer

"Soil Sement" is a latex polymer that is a by-product of the paint industry. Latex polymers are not considered to be long-term stabilizers. When used to stabilize a road with heavy vehicle traffic, it may be necessary to frequently spray a maintenance application coat over the road surface to help hold the fines on the surface and eliminate dust. Even with low use roads or trails it is necessary to do a maintenance application coat every two to three years because the product will breakdown because of environmental conditions. Latex polymers do not do well in aggregate containing clays. These are generally one of the more successful surfacing products. Second best rated stabilizer product.

Mechanical Stabilization

Mechanical stability of a trail surface or tread is achieved due to four interacting factors: aggregate thickness, particle size, compaction and drainage, and lateral stability. Aggregates spread loads throughout their structure. When particles are tightly packed with no voids, the weight of a point-source load is distributed through an aggregate layer like a pyramid, reducing the per-unit-area force at the base. Increasing the aggregate thickness spreads the load over an increasingly wide area. Downward force is greatest below the load point, with diminishing distribution outward. Various sizes of angular particles mechanically interlock into a solid matrix with no voids. Ungraded, unwashed crushed stone contains the original rock binders (natural cements) in the rock dust. The binders in the dust help rebind the crushed aggregate into a solid, compact mass.

To prevent particles from shifting under a load, all voids must be filled. This is achieved by compacting the particles. Larger particles act as the skeleton of the structure, transmitting and spreading forces, while compacted dust and small particles act as binders and a medium to transmit force from one large particle to the next. The particles of the various sizes up to a specified maximum need to be thoroughly mixed to insure that larger particles are embedded in a matrix of smaller ones during compaction.

In any compacted aggregate tread, drainage is essential to long-term stability. If properly graded and compacted, aggregate treads should not hold water. Lateral stability of the trail surface can be increased if a geotextile or geocell soil stabilizer is used, or the width of the trail is contained within an edging material.

Pine tree resin

Formulas such as "Road Oyl" are petroleum -free emulsions formulated with pine tree resin solids in suspension. They are designed to applied cold and work best as a pavement binder when mixed with dense graded aggregate materials. As the water evaporates from the emulsion, the surface will become very hard and will resemble an asphalt surface except for the color, which will usually be a darker shade of brown than the aggregate with which it is mixed. This is the best-rated stabilizer product for universal accessibility. It is also the most expensive and the most difficult to apply.

Psyllium

Psyllium is a powder made from a desert plant called Plantago. This binder can be mixed with crushed stone, clay, and sand to create a trail that is compatible with historic settings. The resulting texture is similar to a baseball infield mix. The stabilizer allows the trail to withstand the wear and tear associated with use by bicycles, strollers, wheelchairs, and pedestrians.

Sulfuric acid

"Roadbond En-1" is a patented liquid road base stabilizer that is mainly a diluted sulfuric acid. It should only be handled when correctly protected with gloves, respirator, goggles, and protective apron as it is corrosive. It is supposed to work well with aggregate containing clay. In studies, it has not held up well through wet and cold seasons and has not noticeably stabilized aggregate materials.

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