BioStripe®

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THE NEW SUSTAINABLILITY FRONTIER: PARKING LOT & ROAD MAINTENANCE

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The New Sustainability Frontier: Parking Lot and Road Maintenance

Sustainability: What is It?

In 1987, the United Nations authorized the Brundtland Commission to explore the impact of human development on the planet and to determine how our activities, if continued, may affect future generations and their ability to sustain life. The Commission recognized that meaningful progress in limiting and/or reversing our impact could only be made by all nations working together rather than a handful of countries and individuals pulling in different directions. “Our Common Future” became the theme of the effort as countries were encouraged to set politics aside and collaborate.

The Commission also determined that Sustainable Development should evolve in the context of environmental, social, technological, and economic conditions to preserve the environment for the future.

Sustainability, in simplest terms, is managing our resources to meet the needs of today’s generation without compromising the needs of future generations. The continued dilapidation of our environment can leave future generations in dire straits, possibly even without reliable sources of fresh drinking water and clean air.

Paving the Planet

In the transportation sector, most environmentalists focus on reducing vehicle emissions, and this attention has paid off. In the past few decades, the automotive industry has and continues to make significant progress in reducing its emissions and environmental impact. Hybrid electric/gasoline systems, clean natural gas, massive improvements in fuel economy, and all-electric vehicles have gained momentum in recent years. While this progress is encouraging, environmentalists agree the transportation industry still has plenty of potential for environmental innovation on.

What about the surfaces upon which these vehicles ride?

Since the late 1800s, asphalt, also known as bituminous, has been the principal material used for paving roads and parking lots. Of the nearly 2.6 million miles of roads in the United States, 94% are paved and repaired using asphalt as the principal material. Concrete is the material of choice for most of the other 6%.

With the U.S. population growth, roads are continuously being added and widened to accommodate increased vehicle traffic. Moreover, with the expansion of shopping malls, “big box” stores, corporate headquarters and sporting venues, sprawling parking lots are growing to massive proportions.

Similar developments are occurring elsewhere. China’s rapid conversion to a modern economy has resulted in an extraordinary growth in auto registrations, with car sales increasing nearly 150% from 2005 to 2016. This increased traffic requires increased infrastructure, which China is constantly working to provide. Like in the U.S., virtually all of this construction involves laying asphalt or concrete.

Requirements for Road Construction Materials and Maintenance

Roadway and parking lot design and construction must accommodate heavy loads of traffic and meet future growth expectations. New roads must be durable enough to ensure motorists and passengers safely reach their destinations. At the same time, they must be economically feasible to ensure public funds are put to their most efficient use. An important—but often overlooked—cost consideration associated with pavement design is labor costs during the life of the pavement. Construction products should require minimal maintenance during their expected life.

As the industry addresses sustainability concerns outlined below, it must do so with these cost and performance parameters in mind. Fortunately, we are well on our way to achieving a more environmentally responsible infrastructure.

Why are Asphalt and Concrete Considered Unsustainable?

There are at least four considerations to address when considering the sustainability of road and parking lot materials:

- **Renewability:** We cannot continue to mine the Earth's resources indefinitely. The essence of sustainability is to develop materials and products that may be recycled and reused rather than continuing to extract these from the earth.
- **Energy Conservation:** The environmental impact of the energy sources required used to mine, transport, and process raw materials have a direct effect on the sustainability of paving or striping material.
- **Emissions:** Some paving installation processes result in harmful emissions. Using low-VOC paving materials, sealants and striping paints helps to mitigate the damage to the environment.
- **Porousness:** Non-porous paving materials prevent rainwater from reaching the soil beneath the surface, preventing natural filtration methods from taking place. Instead, builders must design drainage systems that allow water to flow from roads or lots into sewer systems. This puts an added strain onto our sanitation systems and underlying soil suffers from the lack of hydration.

In recent years, the asphalt industry has made significant strides to reduce harmful emissions at its manufacturing facilities. Recycled asphalt now represents a substantial percentage of the components of new asphalt production, thereby reducing the need for additional new petroleum processing.

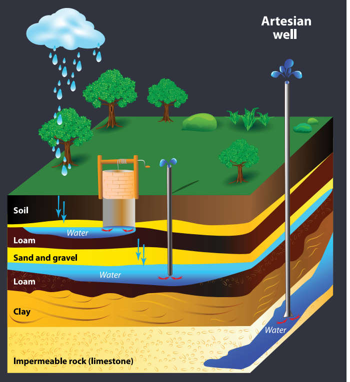
Even with safeguards, the processing of petroleum-based asphalt emits some volatile-organic-compound (VOC) gasses into the air. Collectively, VOC emissions from a wide range of sources are damaging the atmosphere measurably and, if continued, will create problems for future generations.

As human development continues to pave over our natural habitat with impervious materials like asphalt and concrete, a problem has arisen that is already affecting the natural balance of the environment. As rainwater drains away from these paved areas, the ground beneath the pavement becomes abnormally dry. Without moisture, the soil tends to heat up and causes unnatural warming of the surrounding atmosphere.

Compounding the abnormal drying and heating of the subsoil is asphalt's tendency to capture and retain the sun's heat. Asphalt has remarkable heat absorption properties due to its color and chemical composition. This condition is often noticeable as you walk across an asphalt parking lot on a hot day. Heat retention in pavement is also a reason why crowded cities often register temperatures that are several degrees warmer than more natural suburban or rural settings.

Groundwater Issues

Under normal conditions, rainwater replenishes plants and ground cover, then flows away to streams and eventually to the rivers and lakes. During the construction of impervious roads and parking lots, drainage systems are designed to channel water away from pavement to prevent accumulation. These systems usually divert the fresh water into sewer systems and are combined with other sewage materials. This sequence alters natural cycles permanently and results in continuing damage to the world's water supply.



Working Toward Improvement

No matter what the paving material happens to be, infrastructure construction requires considerable energy to accomplish. Moreover, parking lot, road, and highway designs and materials have a significant impact on the amount of fuel burned by the vehicles that travel the road. In recent years, researchers and environmentalists have been pushing hard to influence policy makers and governments to rethink the ways they approach paving construction and maintenance. As a result, both the asphalt and concrete industries have been developing materials and processes that address the environmental issues of land, water and air conservation.

According to a National Geographic article from October 2011, a branch of Environmental Science has evolved to study the impacts of pavement materials and techniques.

What's More Sustainable: Asphalt or Concrete?

Neither material is considered fully sustainable due to their respective compositions. Given asphalt's petroleum base and high-VOC emissions when processed, the material is not considered environmentally positive. Moreover, like other resources of the planet, the supply of raw material is finite.

The production of concrete and its principal binder, cement, may be even more problematic. The amount of energy and the emissions given off in cement processing are massive. For example, according to a National Geographic source, the production of one ton of cement, the binder for concrete, releases a corresponding one ton of carbon dioxide while breaking down in kilns at a temperature of 2,550°F. Typically, kilns used for this process are fueled by highly carbon-intensive coal, which is a significant carbon emission culprit in the process. Interestingly, on many roads, the underlying base for asphalt roadways is concrete. On the positive side, both materials are extraordinarily durable when properly applied. Some decision-makers select concrete for its greater durability. Others prefer asphalt because it tends to be cheaper, easier to apply, repair and maintain.

Recycling Existing Road Materials

There are over 3 million miles of paved roads and parking lots in the United States. Fortunately, we will now be able to recycle most of the road materials when they need repaving in the future. Although the initial damage to the environment during the production of virgin road materials is irreversible, using recycled asphalt and concrete for repaving and new construction greatly reduces the process's environmental impact.

Recycled Asphalt (RAP)

Recycling asphalt into new material for repaving has been accepted in all 50 states. While the practice has been around for decades, the procedures and equipment are improving steadily. While at this time, some states limit percentages of RAP to be aggregated into the finished product for road construction, new technologies have been able to achieve up to 100% RAP content in the hot mix.

Road and parking lot paving use two different processes to recycle asphalt as an aggregate in new material, according to the Federal Highway Administration.

The two methods are:

1. Conventional hot mix in which the recycled material is combined with virgin material and bound with an asphalt cement mix in a central mixing facility.
2. In-place recycling with specialized machinery involves removing the original road surface, hot-mixing with some rejuvenating materials and virgin asphalt or aggregate for strength, and then resurfacing the roadway with the renovated material.

The recycled hot mix procedure begins in the plant with reducing recovered RAP material to coarse particles for better quality control during the heating and mixing process. Gentle crushing by controlling the speed of the equipment creates the right sized, fractured aggregates ready for mixing with the virgin materials. The material must be analyzed for specific properties since the prior time of service of the RAP may have affected the properties of the material. From this analysis, the percentage of new and recycled materials is determined, targeting the most uniform, durable mixture. Temperatures during this mixing process must be held to less than 800°F to prevent excessive hydrocarbon emission.

Hot-in-Place-Recycling completes the removal, hot blending and road resurfacing on the spot. The surface of the old roadway is heated to allow for scarification or breaking up. In a train-type continuous system, the RAP is lifted, heated further, mixed with the necessary amount of rejuvenating material and then replaced as a new road surface.

There are three different ways that hot-in-place asphalt or bituminous is applied. Each process is performed by an inline plant arranged in a continuous system at the site.

1. Heating the surface of the road, often with propane heaters, then scarifying or breaking up the asphalt, adding the necessary rejuvenation components, then repaving. The surface is then compacted using the standard compacting equipment.

2. Repaving requires the removal of the top 1-2" of the old surface, heating and adding new material to rejuvenate the softened RAP to improve viscosity. The equipment then places a thin leveling layer of this material before topping with a 1" to 2" covering of recycled asphalt on the surface. Compacting equipment is designed to create a permanent bond between the original base material and the newly placed asphalt.

3. The remixing process analyzes the RAP removed from the roadway and adds the appropriate amount of new asphalt to achieve a target specification for strength and stability.

Recycled Rubber in Asphalt Production

Since the 1960s, discarded tires are frequently integrated into asphalt production. The performance of recycled tire rubber (RTR) has been a positive recycling opportunity that has worked well in the industry while reducing the amount of tire rubber that reaches the landfill. RTR in asphalt production can substitute as an asphalt binder modifier and mixture additive for surface treatments.

Until recently, only a few states bought in integration of tire rubber into asphalt because alternative materials were cheaper to use than discarded tires. However, since other inputs have become more expensive, discarded tires have remained stable, making RTR an increasingly appealing option.

The Federal Highway Administration has developed a recycled materials policy that states recycled materials should receive first consideration for use, and restrictions that deny the use of recycled materials like RTR without a valid explanation backed supported with proof should be removed from the specifications.

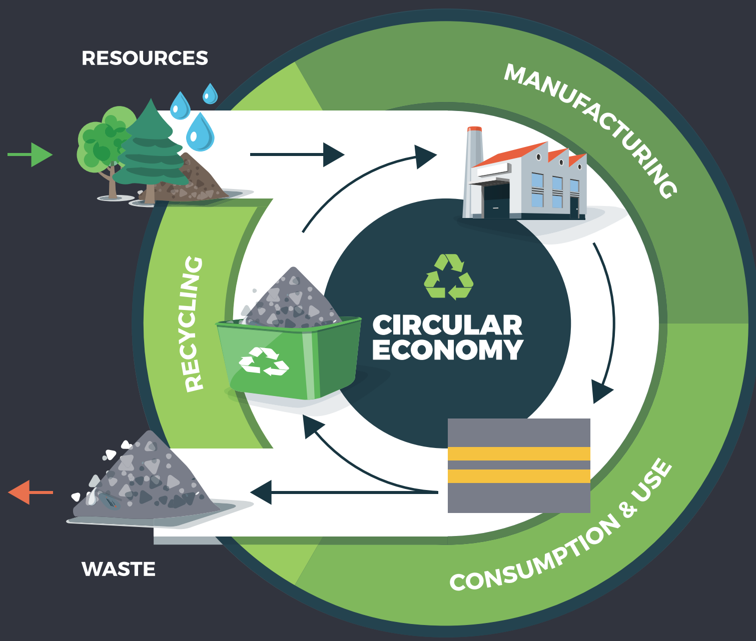
Manufacturing under the guidelines of AASHTO (American Association of State Highway and Transportation Officials), pavement materials must meet Superpave design system standards. Consistency has become less of a challenge since virtually all tires are manufactured using the same combination of components, though the percentages of natural and synthetic rubber may vary.

To prepare used tire material for use in asphalt production, any steel or fiber components must first be removed. The remaining material is either ground or cryogenically fractured into small pieces.

Following preparation for blending, the rubber material is infused into the asphalt preparation either on site or at the plant using one of three different blending processes.environmentally positive products are accepted in greater quantities, the costs of these tend to fall as more producers enter the market. As prices become more comparable, market forces take over and before long, sustainable alternatives overtake incumbent products in the marketplace.

Recycled Concrete Materials

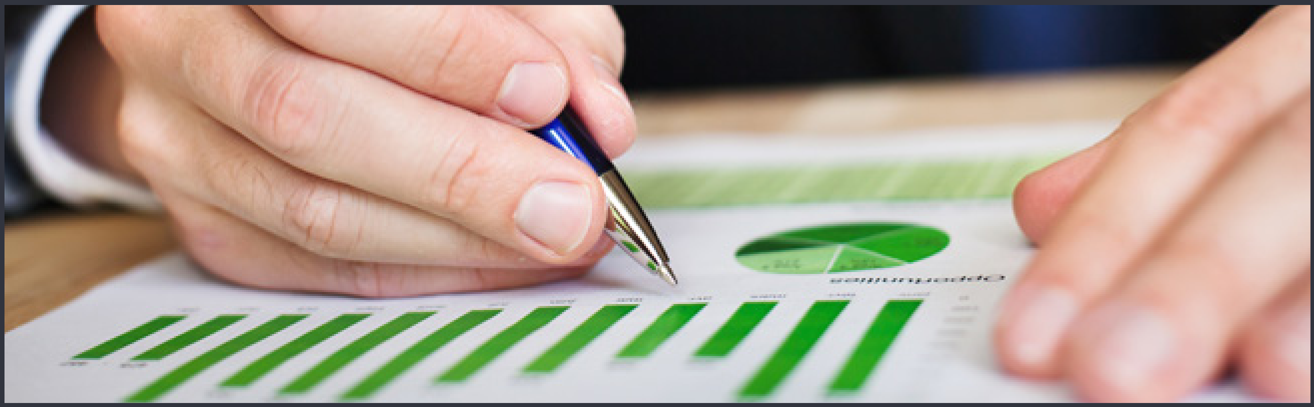
Recycled concrete aggregate (RCA) reduces the demand for producing new concrete. Since the manufacture of the adhesive cement used in producing concrete requires substantial energy while emitting a high volume of carbon dioxide in the process, any reduction in production of new material is a positive step forward. Reusing old concrete eliminates the need to send a massive amount of concrete to the landfill. Moreover, when reduced and blended with aggregate on site, the volume of material to be transported to the construction location is reduced.

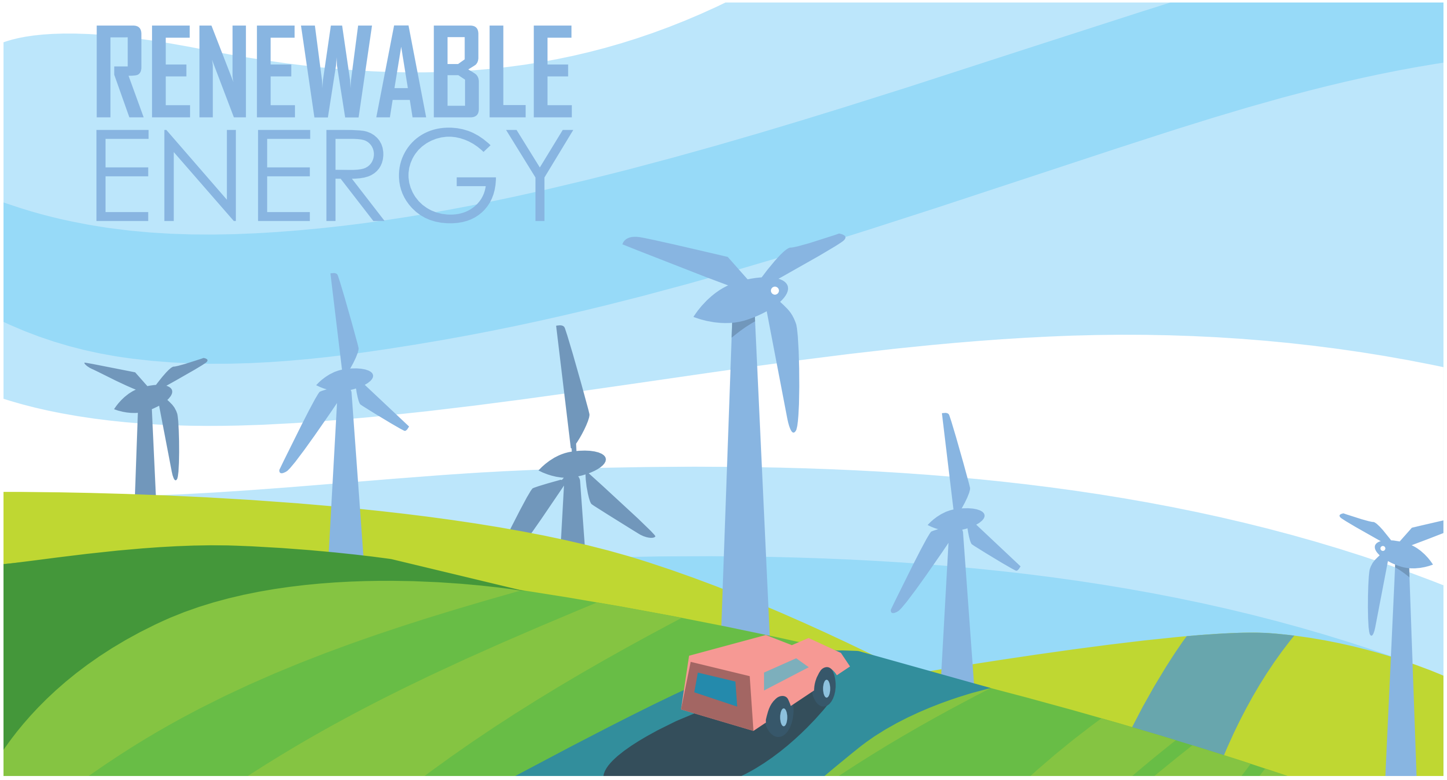


According to an article in the Road and Bridges publication, the chief concern of many governing groups is the presence of a condition known as alkali-silica reaction (ASR) in used concrete. Early studies report that the demolished concrete having the ASR condition may be reactive to the new aggregate during the recycling process. This reaction was assumed to lead to a weakening of the finished material and result in problems in future construction.

An extensive study at Oregon State University took a closer look at the alkali-silica contamination situation. With a complex set of expansion parameters and delicate measuring instruments, the study determined the ratio of new aggregates to the RCA in the new material to be a key variable.

However, in the end, the researchers identified RCA that may be afflicted by ASR can be safely employed if the proper testing is in place. Analyses are essential at all replacement levels to determine possible effects of ASR and identify the appropriate RCA to new aggregate ratios.





Sustainability of Recycled Paving Material

You may recall the four sustainability criteria for road and parking lot construction are renewability, energy conservation, emissions, and porousness or permeability. Recycling existing paving materials tackles some of the criteria for sustainability.

- **Renewability:** reusing existing content is a definite positive. Current and future progress in this category will reduce the need to utilize dwindling raw reserves.

- **Energy Consumption:** recycling RAP is an improvement. Recycling on-site is an even more positive step since it eliminates the need to transport materials to a remote location for processing. Though reducing overall energy consumption by eliminating 100% virgin materials is positive, considerable carbon-based energy is still consumed.

- **Emissions:** to meet the strict specifications for a lasting parking lot or roadway, new asphalt and other rejuvenators and additives must be added. These additives involve high-VOC emissions, though at lower volumes than virgin material. For emissions, recycling is an improvement, but still problematic.

- **Permeability:** does not improve with recycling existing asphalt. As a result, rainwater will continue to flow away from its natural path and filtering systems and into a sewer line or drainage pond. It is safe to say there is little progress in this area from recycling alone.

The Water Drainage Challenge

While recycling is a positive step toward sustainability, permeability and rerouting of rainwater remains a significant issue. Scientists and paving companies are exploring materials and construction methods to mitigate the problem.

Some new porous paving materials are already in place. In eco-friendly Pringle Creek near Salem, Oregon, porous asphalt is the exclusive paving material of the roads, parking lots and alleyways of the 32-acre community. In a 2012 report by the Sightline Institute, the Asphalt Pavement Association of Oregon considered this the first large-scale application of a porous material. The product has held up well, according to the report, but some questions remain. How will a soaked sublayer hold up? How long before the pores become blocked and water cannot seep through? How would the material endure the heavy traffic of busy city streets, crowded parking lots or high-speed interstate highways?

Porous or permeable paving materials consist of a rock and liquid mixture that creates a “lattice effect” of tiny joined open spaces that allow water to pass through. The material creates a “rice crispy” effect as seen from a cross-section view and would be applied over a thick under-layer of gravel to disperse the water further. Engineers must ensure the substrate native soil is not overly compacted to allow for water to continue through the system on its natural path.

According to Sightline, a typical layering from the bottom up consists of the natural native subsoil, an 8” layer of angular rock, 10” of crushed drain rock, a 1” layer of washed aggregate, and topped by the 4.5” layer of porous asphalt.

Porous asphalt construction, produced with recycled RAP and mixed in the right proportion with the coarser ingredients, offers a distinct improvement to rainfall drainage. Placing the pavement upon the substantial rock support system will improve the parking lot or road permeability to allow rainwater to follow nature’s intended route into the subsoil to be channeled directly, with fewer impurities, into the streams, lakes and rivers.

The money saved by not having to build elaborate drainage systems can potentially offset a significant portion of the additional costs of building a durable and sustainable parking lot or road.

What About the Pollutants?

An appropriate supplement to the porous paving material is the addition of a geo-textile material to trap pollutants carried by the water as it passes through the bottom layers of the new pavement. The fabric should be placed between the gravel base layer and the native soil beneath and, besides filtering the pollutants away from the natural soils and water, the material also keeps the gravel from further settling and causing depressions

Seattle Experiments with Permeable Asphalt Surfaces

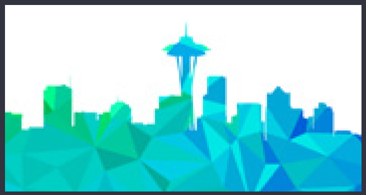
Suburbs and communities around Seattle have been at the forefront of many experiments involving porous asphalt. Through trial and error, different processes have been employed that have either performed extremely well or have highlighted some "don't dos" which have added to the body of learning.

For example, a thick sub-base of rock and gravel is essential. In one instance in Seattle's North End, the asphalt was poured directly onto the dirt without first placing a gravel base. As a result, new rain formed puddles beneath the surface and caused the asphalt to break up and create potholes.

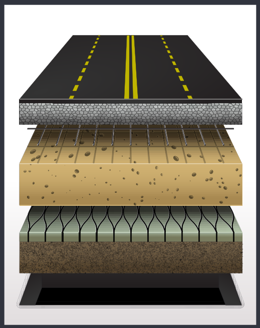
Similarly, road engineers have learned that excess sand and dirt should be kept from piling onto the surface. When this happens, the porous openings fill up. The road will then begin to act the same as conventional asphalt only without the drainage systems that they were hoping to eliminate.

One solution to clogged pores is to blast the pavement with water to dislodge the material and then vacuum, clearing the pavement and allowing proper drainage. At the Pringle Creek location, the residents hire a street vacuum service for $200 to clear the pavement of accumulated debris to allow for unchecked drainage.

Considering Seattle's propensity for rainfall, if the permeable asphalt streets and roads are actively managing the rainwater there, this solution for more sustainable roadways and parking lots should work everywhere. If installed correctly, this technology should allow for new road installation from coast to coast without the cost of redirecting water into expensive detention ponds and concrete culverts.



Porous Concrete Paving



Similar to porous asphalt, the concrete industry has developed porous or pervious concrete and application processes that allow rainwater to flow freely through the structure into the natural subsoils beneath. The Environmental Protection Agency has recognized the use of this type of concrete as one of their Best Management Practices. By using little or no sand in the process, the mixture of aggregate rock and the cementitious material is concrete with many tiny open voids. This new product is durable enough for most situations and allows rainwater to flow freely into the soils beneath the roadway or parking lot.

According to a perviouspavement.org assessment, permeable concrete is the answer for many applications. The product complies with EPA standards, reduces stormwater runoff, drains quickly and eliminates costly alternative drainage infrastructure required by impervious materials.

Porous paving materials have been used for several applications in Europe, including roadways and environmentally friendly parking lots among others. Because of the insulating properties and acoustical characteristics of pervious concrete, there is a growing preference for the material in housing and commercial building.

Processing and maintaining a consistent formulation of raw materials and mix design is critical to a successful application of permeable concrete. Failure here can result in a concrete too brittle for roadwork or too dense to allow water to pass through.

Lot Paving Design

Parking lot design is an excellent place to test and implement sustainable improvements. Issues such as striping paints, improved lighting, stormwater drainage and speed control are all considerations. In many cases, innovations for the sustainable construction and maintenance of parking lots may carry over to roads and highways.

Parking lots cover a major portion of our nation’s landscape. Like roads, parking lots are designed to channel water away from its natural course. Rather than flowing naturally into the streams and rivers, the water is diverted through expensive drainage systems where it is polluted by other urban waste.

Also, traditional asphalt surface parking lots on warm days may heat the surrounding areas by up to 20°F. Furthermore, during a significant storm, sometimes parking lot drainage cannot accommodate the overflow and flooding can occur.

While these exciting innovations impact new parking lot design, there are practices existing parking lots can adopt to improve their sustainability, including:

- Adding and maintain landscaped islands with large trees to add some shade.
- Using a bio-based striping paint like BioStripe®, made from soy oil.
- Replacing existing lighting with solar powered lights.

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