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Why Mechanical Concrete® Unpaved Roads Require Less Maintenance

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Aggregate Behavior and the Role of Water in Road Material Failures

Earthen materials in and of themselves have sufficient compressive strength to support most vehicle generated vertical loads. However, it is also characteristic of all materials under load that a portion of an external vertical load must also be supported horizontally or laterally within the material. This 3 dimensional behavior is known as the Poisson effect. If it lacks this horizontal load supporting capacity the material splits and fails. The most obvious example of this lack of lateral strength is in liquids. For example, water can be placed and confined within a pipe and be pressurized to very high pressures; but by its self, unconfined, can barely support very lightweight objects without letting them sink.

The horizontal load supporting capacity of aggregates, soils and granular materials is dependent on the internal friction that is generated between particles. Internal friction allows the granular material to internally support the horizontal portion of the vertical load. Graded crushed stone materials used to support loads in the bases of roads or on unpaved roads surfaces are usually made up of particles of varying sizes so that the internal friction between particles is optimized. For this purpose, aggregate road construction materials usually contain between 5 and 12% very fine 'binder' particles. This is by design so that the graded particles can be compacted together tightly to optimize the internal friction and thus maximize the resulting compacted material's load supporting capacity. Anything that reduces this internal friction will reduce the capacity of the compacted particulate material to support external loads. Water is the most common element that tends to reduce the internal friction between soil particles. This is why the drainage design of a road is so important and why during the rainy season unpaved roads tend to deteriorate.

Mechanical Concrete® Bases

Mechanical Concrete® road bases do not depend on particle friction or particle to particle adhesion via adhesives for their load supporting capacity. Mechanical Concrete® is made by confining aggregates, soils and granular materials, typically AASHTO #57s, inside a thin-walled geo-cylinder. It is of sufficient strength to support the internal horizontal loads generated by the vertical wheel loads of the passing vehicles. Its horizontal load supporting capacity comes from the strength of the geo-cylinder that directly supports and integrates the stone particles into a 3-dimensional load supporting unit.

The principal geo-cylinder used to make Mechanical Concrete® is a low-cost, tire-derived-cylinder made by removing both sidewalls from a scrap auto tire. This tire-derived-geo-cylinder, TDGC, is extremely strong when reused in construction applications because of the original auto-tire design criteria. In road base use it has a *design factor of at least 5* against the internal loads generated by the maximum over-the-road truck tire vertical loading. So it is a very rugged product which is able to absorb large amounts of energy.

When rains fall on an unpaved road, it is the surface which deteriorates first. A portion of the water which does not run off the road into the ditch is absorbed by the granular surface. This water then saturates the spaces between the soil particles an acts as a lubricate reducing the friction between the particles. The wheel loads of passing vehicles cause this saturated aggregate material to expand laterally in the same way a hamburger on the grill expands when it is pressed by a spatula. The usual result of multiple vehicle passages under these conditions is a pothole or at minimum a rut. These failures first occur in the wearing surface and then, through similar action, in the road base material. The deeper ruts and potholes generate the need for maintaining the unpaved road.

The Three Reasons why Mechanical Concrete® doesn't fail

1. The principle reason Mechanical Concrete® unpaved roads require less maintenance is its behavior in the presence of water. In an unpaved road with a Mechanical Concrete® base, this deterioration process is arrested at the wearing surface. Rain water can cause the compacted surface to deteriorate since it depends on particle friction for its strength. However, the water does not cause the Mechanical Concrete® base to lose its lateral strength; since its strength comes directly from the cylinder material and not internal particle friction. Wearing surface maintenance is easier to perform and less costly than base maintenance.

2. The next reason Mechanical Concrete® unpaved roads require less maintenance is the type of ditch behavior it promotes. Field experience shows that unpaved roads should have a crowns and/ or side slopes of *1 / 2 inch per foot* to support positive drainage. This water is either removed by ditches or through sheet drainage. When ditches are present their side-slopes created by the road-edge tend to deteriorate, and then collapse and fail over time and with use. These ditch wall failures are also a result of water reducing the internal load supporting capacity of the aggregate materials in the road. Mechanical Concrete® road bases eliminate ditch wall failures since the road-edge ditch side-slope is the face of the cylinder which is impervious to water.

3. The final reason Mechanical Concrete® unpaved roads require less maintenance is the superior integration and foundation support it provides. The Mechanical Concrete® base gives superior strength and economy verses the typical unpaved roadway. Its consistent angular interface integrates the wearing surface to function with the base as a unit, more effectively dispersing the loads into the subgrade. Geometrically the tire-derived-geo-

cylinder typically reduces subgrade wheel load pressure by a factor of 2.5 to 3.0. This integration also allows rain water to be better managed, whether it is optimally compacted graded stone wearing surfaces, impregnated with resin soil stabilizers or chip-seal techniques. When properly sloped, unpaved road surfaces with a Mechanical Concrete® bases have a longer useful life.

Reduction in Life Cycle Maintenance

When a Mechanical Concrete® base is present experience indicates a minimum 50% reduction in unpaved road maintenance costs. This level of maintenance cost reduction has occurred on a typical low volume, light duty, rural unpaved rural road in West Virginia that is regularly flooded by a nearby stream. It has also been demonstrated on an industrial unpaved road with an ADT of 300 coal trucks per day. These maintenance reduction results can be achieved in virtually any unpaved road environment. The following are more detail on these two examples of this Mechanical Concrete® maintenance reduction behavior.

Maintenance Reduction on Morgan Run Road Mechanical Concrete® Test Road, WV Division of Highways, Doddridge County, WV

Since the first installation of a Mechanical Concrete® base on Morgan Run Road in September, 2006, this 140 foot test section of one lane, low-volume, unpaved rural has experienced a significant reduction in necessary maintenance. This section of Morgan Run Road is located beside Israel Fork, a stream which drains the hollow served by this section of road. The traffic is basically residential with occasional timber industry and natural gas exploration vehicles.

The Israel Fork floods 3 or 4 times per year usually in the spring and early summer. Prior to the installation of the Mechanical Concrete® base, the post-flood maintenance required grading and reconstruction of ditches, placing some new stone base course, and a new crushed stone wearing surface. Since the 2006 the ditch line has remained intact through the flooding, the Mechanical Concrete® base has resisted the flood water erosion, and the only post flood maintenance required has been to redo the wearing surface the area with new crushed stone.

The former WVDOH Doddridge County supervisor, now a WVDOH District 4 construction supervisor, estimated the reduction in maintenance on this section of Morgan Run Road at 75%. This maintenance reduction comes primarily from the establishment of a permanent base resistant to flood damage, which preserves the ditch line and prevents ditch wall collapse.

Considering the overall impacts of the superior Mechanical Concrete® base on this section of road; it is reasonable to project similar maintenance savings on any low volume, unpaved, rural road.

Maintenance Costs on the MEPCO Stone Surface Loading Dock Road, Morgantown, WV

In the summer of 2011, Laurita Inc. reconstructed an industrial access road at the MEPCO Coal Loading Dock on the Monongahela River near Morgantown, WV. The 300

vehicle ADT of this roadway consists solely of 80,000 lb. coal trucks. These trucks are weighed on a truck scale and then dump their loads for river dock loading. This 24 foot wide truck scale access road consists of a 400 foot length of gravel surface roadway with an 8 inch optimally compacted 1 / 1/2 inch crusher run limestone on top of a 9 inch Mechanical Concrete® base covered with geo-grid mesh prior to placing the wearing surface. Two 100 foot long by 12 feet wide, 10 inch reinforced concrete slabs entering and exiting the truck scale are also supported by a Mechanical Concrete® base consisting of tire-derived-cylinders filled with AASHTO #57 limestone.

By the time this road was reconstructed, maintenance on the prior roadway, a traditionally constructed gravel surface industrial road, usually required two truckloads of crusher runs stone to be spread on the surface each month. This maintenance stone was primarily placed in pot holes, ruts, and generally spread over the surface and lightly compacted and then further compacted by the truck traffic. An estimate of the annual cost is 40 tons of stone per month at a delivered cost of $15 per ton plus $3 per ton for spreading and placing for an annual cost of $8640. [1]

The new road required no maintenance for the first 3 months due to weather conditions. Since then it has taken approximately 2 truckloads of stone in 6 months to repair wearing surface potholes and wash out holes at the ends of the concrete scale approaches and the asphalt entry. These repairs have taken place through the winter and spring rains. This represents an 83% reduction in wearing surface maintenance.

While future wearing surface maintenance may increase, it is observed that over 50% of this roads length has required little or no maintenance during this period. The reduction in road maintenance should be reduced by a minimum of 50% during this roads life cycle. This reduction in maintenance costs is primarily attributable to the inherent strength and ruggedness and the superior drainage characteristics of the Mechanical Concrete® base.

[1] All road maintenance costs are based on information acquired in conversations with MEPCO and Laurita, Inc. personnel