Building Better Rural Roads: New Mexico's First RoadPacker Natural Ionic Soil Stabilized Road

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In October 2010, New Mexico became a trendsetter in the United States for rural road construction. Many of the back roads in the Intermountain West are causing headaches for their management in construction, maintenance and repair costs, particularly with regard to washboarding, dust abatement, raveling, rutting, pot-holing, and the soil's ability to absorb water. In Santa Fe County, in the upper reaches of Glorieta Mesa, Bob Sherwin of RoadPacker NM and Brad Holian, a scientific consultant, a semi-retired theoretical chemist, and physicist at Los Alamos, have begun to address these problematic dirt roads in a two-pronged approach to building low-maintenance, sustainable roads that gently and efficiently guide water to the downhill side of the road.

RoadPacker International produces natural ionic soil stabilization solutions that utilize native on-site soil to construct effective, rock-like road surfaces for dirt roads and subgrades and base course for paved roads that are highly water repellent. Simultaneously, the Water Harvesting Method of dirt road construction, outlined in the manual, "A Good Road Lies Easy on the Land…" by Bill Zeedyk and published by The Quivira Coalition, is being used to design rural roads that minimize the road's impact on its environment.

Together, these two methods benefit from one another in creating a powerful end result. By combining the RoadPacker products with the effective Water Harvesting Method of drainage, roads are being built that are designed with a consciousness towards efficiency, durability, and the road's environmental impacts. This improves roads for the land owners, vehicles, drivers, and the environment.

STEP ONE:

The first prong of the approach used by RoadPacker NM on the Glorieta Mesa was to make the surface of the contoured road as impenetrable to water and as impervious to traffic as possible. In this regard, RoadPacker NM employed natural ionic soil stabilizers (commercial names RoadBond and RoadPacker) that take naturally occurring clays in the soil and turn them into a synthetic rock.

In the past, road stabilizers have often employed toxic materials such as magnesium chloride, enzymes that resemble detergents, and cement. These older methods provide short-lived utility and have been associated with serious environmental damage to roadside vegetation, leaching into the soil, and pollution in streams and groundwater. These new stabilizer compounds produced by RoadPacker International are non-toxic and have the durability to last for decades with little or no maintenance. They react so thoroughly with clay in the soil that the roadbed becomes electrochemically water repellent, improving:

- road density due to enhanced compaction
- load-bearing capability (CBR)
- the soil's affinity to water, making it waterproof
- durability, and
- pavement life

while reducing:

- the road's plasticity index (PI)
- dust generation
- loss due to erosion
- loss due to abrasion
- shrinkage
- swelling
- raveling
- rutting
- washboarding, and
- frost heave

The chemistry behind the new type of soil stabilizer was discovered almost by accident in the 1920s when paper mills were forbidden to dump their waste products into rivers due to their toxicity. (To make paper, wood pulp is treated with sulfuric acid to extract lignin from cellulose; lignin is a class of incredibly long and complex polymeric chains that form the structural secondary cell-wall fibers of wood, giving it its flexible strength.) The paper industry then began to spray this waste material, a mixture of lignosulphonate, acids, and other contaminants onto roads for dust suppression. People noticed that some of the roads hardened after treatment while other roads did not. It took more than twenty years for dedicated scientists to discover that the underlying hardening depended upon naturally occurring clay in the road soils. In the 1980s, after this type of crude dust suppressant encountered opposition in Canada, a country with some of the most restrictive environmental impact laws, a new manufacturing process was perfected, and the new, environmentally friendly, nontoxic soil stabilizers (RoadPacker Plus and RoadBond) were approved for use on dirt roads by the Canadian government.

RoadPacker International has seen incredible success all over the world, from the cold, harsh climate of Russia to the humid, tropical environment of Costa Rica. Only recently has this product been introduced to the United States.

The main stabilizer compound is calcium lignosulphonate, a complex molecule composed of long polymers of lignin attached to a sulphonate group, which reacts with the clay in soils. Clay is weathered rock mineral in the form of hydrous aluminum phyllosilicates; when lubricated by water, the microscopic platelets of clay slide over each other to form the nasty, slippery goo creating muddy roads. When lignosulphonate reacts with clay, however, it expels water molecules attached, allowing for high levels of compaction (100% plus and even known to reach levels as high as 130%). The result is an incredibly strong, resilient, rock-like road surface with flexible load-bearing capabilities that far exceed that of other stabilizers such as cement.

To prepare the roadbed, a road grader with an attached ripper on the back first digs up the soil, including any previously added base course gravel, to a depth of six to eight inches. Soil samples are required in advance to determine the clay content and the pH (acidity or alkalinity) of the soil, which determines the specifications of the RoadPacker Plus or RoadBond product that will be used. Both RoadPacker Plus and RoadBond require a clay content of 15% to 50%, the range that is found in most soils in the world. For soils that are too sandy, additional clay from outside sources may be required, while soils with clay content over 50% may need to have sand or gravel added.

Next, a water-truck (adjusted to the appropriate pH) hydrates the soil, which is mixed thoroughly by a heavy-duty disk and/or by grading back and forth, creating windrows, in order to achieve the soil's "optimal moisture content" (OMC). The practical meaning of OMC is this: grasp a handful of soil and squeeze it; if water drips out of your hand, the soil is too moist and must be dried or it will stick to the compaction

equipment; alternatively, if the soil crumbles in your hand, it is too dry and will not achieve optimum compaction. Once OMC is achieved, the concentrated stabilizer is diluted 3:1 with water, and a second water-truck, fitted with a customized watering bar, sprays the solution directly downward onto the roadbed, so that no stabilizer is wasted on roadside banks. Either RoadPacker Plus or RoadBond stabilizer is used, depending on the clay content and pH of the soil, though the cost per mile of the two stabilizer formulations is essentially equivalent. Final thorough mixing by a road grader or disk harrow begins the process of chemical reaction with the clay. The roadbed material is then shaped into Zeedyk contours, compacted by a knobby sheep's-foot roller, and finally smoothed by a 12-22 ton vibratory metal-drum roller. After spraying lightly with water, the roadbed is ready for traffic immediately, with full curing in about four weeks.

The stabilized soil becomes as hard as a rock, yet retains the flexibility and resilience of wood with the ability to bear heavy loads. In Canada, Mexico, and South Africa, mining roads have been in operation day and night without stopping for years, some bearing 240-ton ore trucks, and in extreme weather conditions, including five months of heavy snow.

The stabilized dirt road is relatively inexpensive to build and maintain, being two or more times less costly as roads with aggregate mixtures and about ten or more times less costly than asphalt paving.

There are other applications of soil stabilizers beyond rural dirt roads like the recent application on Glorieta Mesa. For example, RoadPacker Plus or RoadBond has been used to make aircraft runways that can accommodate heavy commercial jets. RoadPacker Group products can also be applied to the soil before constructing the foundations to houses to stabilize the soil to avoid the damaging effects of expanding and contracting soils. Soils treated with the RoadPacker International's natural ionic soil stabilizers become so water repellent they are effectively waterproof, lending themselves to further uses. RoadPacker Plus has been used to create natural soil liners to hold water in ponds, for such diverse applications as ranch stock ponds and golf courses. For roads where traffic levels are high and asphalt paving is necessary, the underlying subgrade and base course can be treated with RoadPacker Plus or RoadBond and the thickness of the asphalt can be reduced to two inches, compared to the usual four to six inches. The resulting paved road will last at least twice as long as one built in the traditional method. By using half or even a third of the asphalt while at the same time doubling a paved road's longevity, tremendous savings can be generated for both the private and public sector.

STEP 2

The second prong in the experiment conducted at Glorieta Mesa began even before RoadPacker product was introduced into the road. The road was closely observed in order to understand and determine the natural tendencies it has in diverting and pooling water run-off. The Water Harvesting Method is an intelligent road design that takes into account the natural flow of water on the landscape. It is often the case that dirt roadbeds have been constructed without regard to their impact on the health and sustainability of the land.

Bill Zeedyk, the author of "A Good Road Lies Easy on the Land…," has been promoting ranch road engineering and methods of watershed restoration for 20 years since retiring from the U.S. Forest Service as Staff Director for Wildlife and Fisheries Management, Southwestern Region. Currently, he works as a consultant for The Quivira Coalition, a local Santa Fe non-profit that promotes land health throughout the Southwest. The Water Harvesting Method described in Bill's book begins first by casting one's eye upon the land. Wherever the flow of water crosses the road, one tries to imagine the gentlest way to coax the water diagonally across the road toward the downhill side, toward the vegetation that needs the water.

Instead of installing a metal culvert to divert water underneath the road, a large expense in material cost, installation and maintenance, a diagonal slope can be built into the road with gentle berms that are built up about a foot over a total travel distance of about 80 feet. The resulting rolling dip is so subtle that a vehicle hardly feels the "bump," yet rainwater and snowmelt is persuaded to take gravity's gentle hint. Rock dams on the uphill side of a ditch and cutouts on the downhill side of a ditch augment the water-conducting action of the rolling dip to create a simple yet effective approach to runoff water management and land stewardship.

By shaping the road as closely as possible to the original landscape, the Water Harvesting Method recreates a natural pattern of flowing water which benefits the trees and vegetation on either side of the road. The approach is simple:

1. get the water off the road as soon as possible,
2. in the best place possible, and
3. as often as possible

In this way, the road assists in directing water away from the road and into the road's surroundings where it can be beneficial rather than entraining it in the dirt road where it can do great damage.

THE FINISHED PRODUCT and THE POTENTIAL

The combination of both RoadPacker products and the Water Harvesting Method shifts the paradigm in the United States in rural road surface, subgrade and base course stabilization. The two approaches augment each other by incorporating intelligent design and planning of roads into the natural landscape surrounding the road. These roads experience less erosion, are longer-lived, require little to no maintenance, are more environmentally friendly and are cheaper to build and maintain than older methods of rural and non-rural road construction.

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