Noble County Highway - Partial Depth Reclamation

Zack Smith – County Highway Engineer

Noble County Highway Department utilizes partial depth reclamation as a cost effective road reconstruction technique. We reconstruct roads that are rated a three on worse on our Annual Pavement Inspections (PASAR), see below for an example. This process focuses on drastically improving a roadway's base strength as oppose to improving the surface through a traditional reconstruction. The base is strengthened through the addition of new high quality aggregate and chemical modified using Calcium Chloride and Lime Hardening. Other reclamation processes utilize asphalt or cementitious materials; however, we have found calcium chloride to be significantly more cost effective and easier to install. The year before any reconstruction project all drainage (culverts and ditches) are brought up to current standards.

The first step in our process is to layout additional aggregate on the roadway as seen below. We use a steel slag aggregate called Duraberm, supplied by the Edw. C. Levy Company. Duraberm is a heavy aggregate that contains natural lime (CaO) from the steel production process. Duraberm has a gradation similar to INDOT No.53 / No. 73 aggregate (see below) and is ideal for a road base material. An average of 2.5" of aggregate is tailgated over the desired roadway width and graded to a uniform cross section. During this process, the road can be widened up to 1' to 2' on each shoulder.

Target Gradation 1" X 0 - Duraberm	
Sieve	**Percent Passing**
1"	100
3/8"	50-85
#4	35-65
#8	20-40
#16	12-30
#50	5-20
#200	4-15

Next, the Duraberm is treated with Calcium Chloride (42%) at a rate of 0.5 gal per square yard. The hygroscopic and deliquescent properties of Calcium Chloride allow the base to absorb moisture from the air and resist evaporation. This results in long-term ideal moisture content which provides a denser, stronger base due to higher surface tension and retention of fine aggregates. Additionally, the moisture from the Calcium Chloride activates the lime in the Duraberm resulting in lime hardening ($CaO + H_2O > Ca(OH)_2$.) See below the typical Triaxial Strength Data. Noble County uses 2.5" of slag per 8" of reclamation, which is ~30% blend. High percentage slag blends may have expansion issues and are not as cost effective as the 30% blend.

Triaxial Data	Unconfined Compression	
	No Aging	28 Day
Existing Roadway	23.0 psi	46.5 psi
W/ 30% Blend	26.4 psi	80.9 psi
W/ 40% Blend	39.5 psi	85.3 psi
W/ 50% Blend	57.5 psi	90.3 psi
W/ 60% Blend	61.8 psi	96.0 psi

Next, the material is recycled into the road base at a Depth of ~8" using a Bomag MPH125 Recycler, see below. Core samples or historical data should be reviewed before recycling to ensure that the subbase is not punctured during the process. Following the recycler, a Bomag BW213PD Sheepsfoot Roller is used for initial compaction.

Next, a grader sets rough grade on the road, followed by a pneumatic rubber tire roller. This is followed by another grader that sets final grade and a steel drum roller. Once final grade is set, the surface is treated with Calcium Chloride (42%) at a rate of 0.25 gal per square yard. This is to aid in the curing process and also acts as dust control by retaining fine aggregate. The road is left to cure for 28 days, while open to traffic. Following this period, any required maintenance is addressed and a surface treatment is applied. Noble County uses either a triple chip and seal with fog seal or 1.5" HMA surface course.

Take Away's

We have chosen to use a partial depth method vs. a full depth method because it provides the required strength needed for county roads without the risk of punching through the sub-base and is significantly more cost effective than full depth reclamation.

We have chosen to go with Calcium Chloride and Steel Slag modification because they work extremely well in tandem, are easily applied and provide significant cost savings when compared to cement or asphalt injection.

The reason this method works so well is the combination of creating a road base with ideal gradation from the added aggregate, recycler and triple compaction, ideal moisture content from Calcium Chloride and chemical lime hardening from the steel slag. There is also the added benefit of a lower road base frost temperature, dust control and evaporation resistance.

We complete all construction using in-house labor and equipment. We rent the specialty recycler machine and the sheepsfoot roller. The base reconstruction process was completed at a material and rental (no labor) cost of $29,442 per mile for a 22' wide road. With a triple chip and seal with fog seal the total cost is $67,323 per mile. With a 1.5" HMA over lay, the total cost is 90,774 per mile. These cost are significantly less than full depth reclamation (using cement or asphalt) ~$200,000 -$300,000 per mile plus surface or traditional reconstruction ~$300,000 - $500,000 or more.