

Benefits of Testing Aggregate

It is important that managers of local street and highway departments know that all gravel is not the same. You can tell a little about it by visual inspection or by running your hands through the material. But the quality of the aggregate only can be determined through testing.

Testing aggregates requires special knowledge and equipment that generally is not available or affordable to most local road agencies.

However, it's important that agency managers and local government officials have a good understanding of the benefits of testing aggregate to improve road construction and maintenance.

The goal of this issue of StreetWise is to describe the benefits of knowing more about aggregate that is used in your construction and maintenance operations. This knowledge will help you specify good materials, decide when to accept or reject materials and to better communicate with crushing contractors, consultants, NDOT and others involved in building and maintaining roads.

Sampling

Another issue critical to testing aggregate is obtaining a good sample of the material to be tested. Knowing how to get a good representative sample from a crushing operation, a stockpile, a windrow or a paving operation is critical to obtaining good test results from a lab.



This stockpile is to be used as surface gravel on a road, but how do you know it will be good surfacing?

Poor sampling techniques have led to more controversy in aggregate testing than any other factor. Every effort must be made to make sure that the sample brought to a lab is truly representative of the material that was crushed that day. It is advisable to work with an experienced sampler. The T² Center has an excellent video titled "Sampling Aggregates." To borrow the video just call the Center at: 775/784-1433.

Gradation

A primary concern when testing aggregate is gradation of material. The specified gradation dictates the size of particles blended together to create a usable gravel. Depending on what the material is to be used for, the gradation of the blend varies greatly.

For example, good gravel surfacing material for a construction of a gravel roads needs more material passing through a #200 sieve than a good base course material. There also is a difference in the need for plastic material. Surface gravel needs some good natural clay that gives a "binding characteristic."

In testing aggregate it is best to use standard specifications as a start. Notice the major differences in the specifications in Table 1 in the largest size material and the smallest size material.

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The base course requires 100 percent of the material to pass through a 1-inch sieve but allows up to 20 percent of the coarse aggregate to be retained on the ¾-inch sieve. Although this could make excellent base course, it likely would be a disaster if used as gravel surfacing. There would be too much large stone, and blade maintenance would become very difficult.

In addition, the high percentage of coarse material would make a rough driving surface. Yet, some percentage of coarse aggregate is needed for strength in base course.

Plasticity

Notice also the difference in the fine material and the plasticity index (PI). Although gravel surfacing allows not less than 4 percent but up to 15 percent of the material to pass through a #200 sieve, base course can have as little as 3 percent, but not more than 12 percent passing through the same sieve.

More importantly, the PI can fall to 0 in base course and rise to no more than 6. The same index can rise as high as 12 percent or be no less than 4 percent in surface gravel.

There is a good reason for this. Surface gravel needs a percentage of plastic material, usually natural clays that will give the gravel a "binding" characteristic resulting in a smooth driving surface. This is critical during dry weather. During wet weather the surface may rut a bit but will quickly dry and harden in sunny and windy weather.

However, any great quantity of plastic fines in base gravel will cause problems. If moisture gets under the paved surface, the base will lose its strength and stability and cause rutting or even failure of the pavement.

Too often the same gravel is used for both base work and surface gravel. Generally, it will be good for one purpose or the other but will not work for both applications.

It is particularly hard to determine plasticity without testing. This is a laboratory test that in simplified terms tells you whether the fines are clays or silts.

Specification differences

Consider the differences in the specifications in Table 2. Type 2 is a crushed gravel specification for hot-mixed asphalt. Screenings, Grade 2 is a specification for cover aggregate used in chip sealing.

Again, the largest size aggregate is the first difference. There is a percentage of larger aggregate needed for strength in asphalt paving mixes. When chip sealing, the large stone is not desirable. It is hard to retain in the liquid asphalt and causes windshield damage, excess tire noise and is prone to being dislodged by snow plows.

One specification calls for 100 percent of the aggregate passing through a 1-inch sieve while the other requires 100 percent passing through a ½-inch sieve. The difference

seems small. But if you try using the larger stone for seal coating, you'll see a dramatic difference.

As you glance down through the sieve requirements, it is obvious that the aggregate for asphalt concrete is a "well-graded" or "dense-graded" material. For example, there are uniform decreasing percentage requirements for specified sieve sizes. The plasticity index is also low to keep the potential of clay particles at a minimum.

The chip seal blend will have much smaller sized aggregate. The specifications require most of the aggregates to be in a size range from ¾-inch to No. 4. This type of gradation is referred to as "uniformly-graded" or "open-graded." The goal is to reduce the smaller size particles. Note also the plasticity index is not specified. This is because of the low percentage of No. 200 which is allowed in the blend.

Quality control

Approximately 94 percent (by weight) of hot mix is the aggregate. Only the remaining 6 percent is asphalt cement. Although we are generally very concerned that the asphalt cement is of the right type and is mixed at exactly the right percentage, we often do not pay enough attention to the far greater quantity of the mix -- the aggregate blend.

This also is true of material used for many other purposes. We have often seen pavement failures that occurred because the base gravel was not of good enough quality.

It is even critical that common surface gravel used on gravel roads be of good quality to avoid problems with excess wash boarding, rutting in wet weather or loosening in dry weather.

Cost benefit

Objections may be raised about the cost of sampling and testing. However, if you plan to crush 50,000 tons of plain surface gravel, it's certainly worth a few hundred dollars for testing to assure yourself that the material is good.

Also, if the test fails you can work with the crushing contractor to try to blend and improve the gravel. This becomes even more critical in producing material for pavement or base.



Table 1. Example of Gradation and Plasticity Requirements for Two Aggregate Gradations*

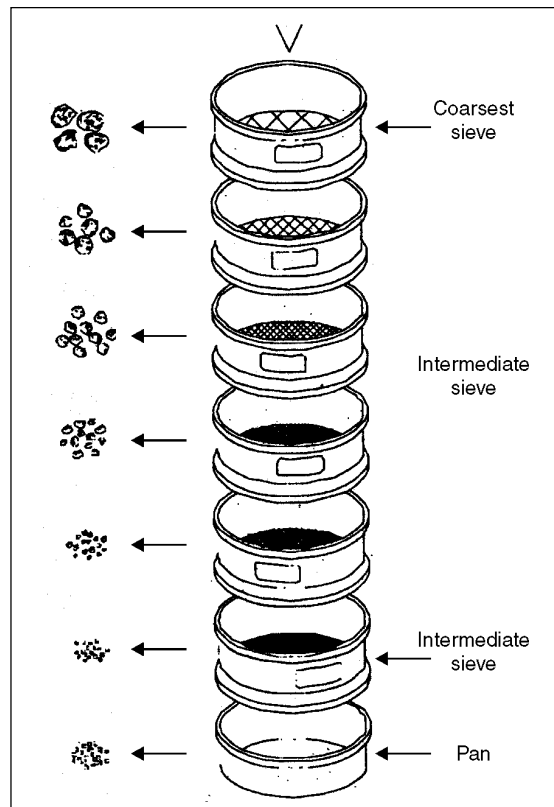
Specification Requirements	Typical Aggregate Base Course	Typical Gravel Surfacing
1 inch	100	
¾ inch	80–100	100
½ inch	68–91	
No. 4	46–70	50–78
No. 8	34–54	37–67
No. 40	13–35	13–35
No. 200	3–12	4–15
Plasticity Index	0–6	4–12

* Specifications are from Section 882 of South Dakota DOT Standard Specifications for Roads and Bridges

Table 2. Specifications for Aggregates in Making Hot Mix Asphalt and Chip Sealing**

Specification Requirements	Aggregate for Asphalt Concrete	Aggregate for Surface Treatment
	NDOT Type 2	NDOT Screenings Grade 2
1 inch	100	
¾ inch	90–100	
½ inch	–	100
¾ inch	63–85	50–80
No. 4	45–63	0–15
No. 8	–	0–5
No. 10	30–44	–
No. 40	12–22	–
No. 200	3–7	0–2
Plasticity Index	0–3	–

**Specifications are from Section 705 of NDOT Standard Specifications for Roads and Bridge Construction



A stack of sieves used for testing the gradation of aggregate.

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For additional information, contact the Nevada T² Center at the address shown below.

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