Technical Bulletin

Aggregate 101

3/2025

Center for Dirt and Gravel Road Studies

Aggregate – A mixture of crushed rock or gravel separable by mechanical means. Focus on road applications.

Aggregate from sedimentary rock in SW PA

Source (Geologic Origin) – Most PA aggregates are mined from sedimentary rock such as limestone and sandstone. In the glaciated regions of NW and NE PA, aggregate is often mined glacial till, or pit-run gravel. In general, limestone is the hardest of the rocks, with shale being the softest, while pit-run varies widely in its usefulness as a road aggregate.

Gradation – The distribution by percent of weight of different sized stones comprising an aggregate. Determined by sieve separation and the loss by washing of material finer than the No. 200 sieve (~0.003 inches).

Aggregate sieves

AASHTO Number	Total Percent Passing													
	100 mm (4")	90 mm (3 1/2")	63 mm (2 1/2")	50 mm (2")	37.5 mm (1 1/2")	25.0 mm (1")	19.0 mm (3/4")	12.5 mm (1/2")	9.5 mm (3/8")	4.75 mm (No. 4)	2.36 mm (No. 8)	1.18 mm (No. 16)	150 µm (No. 100)	75 µm (No. 200) ***
1	100	90-100	25-60		0-15		0-5							

Aggregate specifications have an allowable range of different stone sizes, expressed as a percentage of the total weight of sample. This **gradation specification** is reported on a table or chart (see example above). The *nominal* maximum size of an aggregate specification is defined as the smallest sieve opening through which 100% of the aggregate can pass.

Open-graded

Open graded aggregates are "porous" with notable air voids between individual stones, and little to no "fines". These mixtures drain effectively, but do not compact well to form a dense conglomerate. Road applications include use as base material and for subsurface drainage.

Well-graded

Well graded aggregates are "dense" with few air voids between individual stones. These mixtures are not suitable for drainage, but are preferred for use as surface aggregates as they tend to compact well to maintain desired road shape, lengthening grading cycles. This is also a key component in extending the road life cycle for traffic support.

Aggregate Quality or Type is primarily based on the resistance to weathering (soundness), the resistance to traffic (abrasion) and the absence of extraneous undesirable material. For both soundness and abrasion the maximum allowable amount is expressed as a percentage (by weight) of material changed by specific tests. For undesirable material the maximum allowable amount is expressed as a percentage (by weight) of the total weight of the mixture. For these parameters a maximum allowable percentage is set for each aggregate Type (A,B & C). Lower numbers represent higher quality. Lower quality aggregates should be reserved for fill and sub-base applications only.

PennDOT	Type A	Type B	Type C
Soundness, Max %	10	12	20
Abrasion, Max %	40	45	55
Undesirable, Max %	2	2	15

PI, or Plasticity Index is a measure of the plasticity of a soil. *Soils with a high PI tend to be clay.* Ideally, surface aggregates should be non-plastic to slightly plastic with a PI of 6 or lower.

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A PennDOT **Material Certification** is documentation attesting that a specific product meets the requirements for Gradation and Properties outlined in *PennDOT Publication 408, Section 703*. Tests and documentation must be completed by a PennDOT certified lab technician. For DSA used on Dirt and Gravel Road Maintenance Program projects, a certification must be delivered with the first load of material for each day of the project.

Common Course Aggregates for Road Applications in PA

	AGGREGATE SPECIFICATION		Common Name	General Size Description	General Uses	TOTAL PERCENT PASSING													
						100mm	90mm	63mm	50mm	37.5mm	25mm	19mm	12.5mm	9.5mm	4.75mm	2.63mm	1.18mm	0.15mm	0.075mm
	AASHTO	PA				4"	3.5"	2.5"	2"	1.5"	1"	3/4"	1/2"	3/8"	#4	#8	#16	#100	#200
open graded	#1	#4	ballast	4"- 3/4" clean	road base, buried drains	100	90-100	25-60		0-15		0-5							
	#3	3A		2.5" - 1/2" clean	haul road surface, choke			100	90-100	35-70	0-15		0-5						
	#57	2B		1.5" - 3/32" clean	buried drains					100	95-100		25-60		0-10	0-5			
	#8	1B		1/2" - 3/32" clean	chip surfacing								100	85-100	10-30	0-10	0-5		
	#10		grit, screenings	less than 3/8"	trail surface, anti-skid									100	85-100			10-30	
well graded		2A	modified?	2" - fine	road base, road surface				100			52-100		36-70	24-50	16-38	10-30		0-10
		2RC	misc., reclaim	varies widely	fill, pipe bedding, surface				100						15-60			0-30	
		DSA	driving surf. agg.	1.5" - fine	unbound road Surface					100		65-95			30-65		15-32		11-15
		TSA	trail surface agg.	1/2" - fine	unbound trail Surface								100	90-100	50-85	35-60	25-50		12-18

The AASHTO numbering system labels aggregate specifications from 1 to 10 according to the largest stone size in the mixture, with 1 being the largest (all material passing a 4" sieve opening) and 10 being the smallest (all material passing a 3/8" sieve opening). Multi-digit specifications represent a blend of one or more of the ten basic specifications (i.e. AASHTO 57 is a blend of AASHTO 5 and AASHTO 7). AASHTO Specifications are technically open graded aggregate.

Common Rip-Rap Specifications in PA

Rip-rap is a loose assemblage of larger stone that is most often used for bank and abutment protection at stream interfaces, for armoring and velocity checks in road ditches and outlets, and for slope protection on road banks. Specifications that begin with an "R" designation are set by the National Crushed Stone Association.

SPEC / NAME	Size Range	Average Size	General Uses	TOTAL PERCENT PASSING										
				42"	30"	24"	18"	15"	12"	9"	6"	4"	3"	2"
R-8	15-42"	28"	abutments	100		15-50		0-15						
R-7	12-30"	20"	streambanks		100		15-50		0-15					
R-6	9-24"	14"	streambanks			100		15-50		0-15				
R-5	4-18"	11"	streambanks / ditches				100			15-50		0-15		
R-4	3-12"	7"	ditches						100		15-50		0-15	
R-3	2-6"	3.5"	road subbase								100		15-50	0-15
Surge	10"-fine	*varies*	subbase / fill	Surge, Gabion, and Shot Rock are relatively loose terms with broader size ranges and no exact specification.										
Gabion	4-8"	*varies*	baskets / ditches											
Shot Rock	*varies*	24"	abutments											

What is a "modified" aggregate?

Technically PennDOT no longer has a "modified" specification. However, this term continues to be used by stone customers and suppliers. An aggregate is "modified" when fines (smaller than 0.075 mm (0.003") /No. 200 sieve) are blended into a standard aggregate specification to increase the fine content of the mix. "Modifying" can change an open graded aggregate to a well graded aggregate, enhancing its density and usefulness as a road surface material. In PA, the most common aggregate to "modify" is PennDOT 2A.

Terms to know:

- **Gravel** – naturally unconsolidated rock fragments
- **Stone** – rock crushed to a specific size and shape
- **Sand** – rock particles smaller than 3/8" (majority smaller than 3/16")
- **AASHTO** – American Association of State Highway and Transportation Officials
- **NCSA** – National Crushed Stone Association

PennState