

**CRUSHED AND STOCKPILED GRAVEL ROAD SURFACING AGGREGATE
(10-19-2016)**

Please delete the first two pages of this document (the user note) prior to putting the spec into a contract

Specification User Note: This three page gravel crushing spec is intended to produce gravel that will develop a good road crust, resist raveling and wash boarding and also retain chloride dust abatement. Additional edits to this spec are likely needed even though it was written in collaboration with three county road departments, two consulting firms, five crushing contractors and was used in two 2016 Contracts. For additional information or feedback, please contact stevemonlux@gmail.com or 406-544-1919.

Critical elements of this specification include the following:

Subsection 2.2A

- a. The pay adjustment factor concept increases contractor performance and reduces disputes when materials are out of specification. **For the pay adjustment to be effective there must be a 10% limitation on the mobilization bid item to prevent unbalanced bidding.**
- b. Gradation, fracture and plasticity index test results must be tailored to materials sources that are owned by counties or available commercially. Prior to contract advertisement, sample and test designated sources, then edit Table 1 to make sure spec limits are realistic. The 5/8" minus gradations shown in Table 1 was selected because materials sources in Eastern Montana & North Dakota have small rock and % fracture is difficult to obtain. A rockier gradation table is shown at the end of this user note. Deleting the PI requirements will reduce cost and is suggested when (1) clay in source is known to be adequate or (2) two percent bentonite or four percent stockpiled clay is specified. I can provide some free assistance to help sort this out.

Subsection 2.2B. Basing acceptance on the average of all daily test results will lower bids and better represents gravel placed on the road since mixing occurs while loading out stockpiles.

Subsection 2.2C. Since contractor testing controls the quality of gravel, the splitting of samples and testing must be done correctly. The County consultant lab is the most qualified party to check out the test procedures and equipment. This checking process builds relationships between the two parties ahead of a dispute over test results that are always counterproductive.

Subsection 2.3A. The daily sample process will normally produce an adequate number of samples and helps avoid bias in sampling by taking a number of samples that form a composite sample over an entire day as opposed to the typical snapshot sample.

Subsection 2.3B. Having the contractor test a split of the acceptance sample helps ensure the contractor testing is on track by comparisons with the Consultant lab, so the owner knows that crushing adjustments are based on reliable information.

Subsection 3.1A. The stockpile floor requirements are included where Counties do not have the resources or time to prepare a proper floor. The need for a four inch layer of crushed aggregate on the floor may not be necessary when a stable pit run floor is available. Normally at the start of crushing, some crushed aggregate is out of spec and is used to build the floor.

Subsection 3.1B. The first sentence of this paragraph is pretty standard. The water requirement is a product of frustration with the typical rotary stacking conveyors that cause segregation – requiring water will not increase bids as much as prohibiting the use of rotary stacking conveyors.

Subsection 3.2A. Selecting one of the four options involving clay binder in the gravel really depends on the materials source and how much you want to spend to achieve a gradation that builds a good road crust that reduces gravel loss, raveling and wash boarding. If the gravel source is non-plastic, adding 2% bentonite or 4% bank run clay is normally safe – overdosing will build a good road crust, but will cause slippery roads and severe rutting in the spring. Edit requirements in Table 1 to be consistent with the option selected. Please contact me if you want additional suggestions.

Subsection 3.2C. This paragraph contains the typical disclaimer language needed when a county source is designated. Normally, if good source investigation methods are used and specs are tailored to the source (item #2 above) problems will be avoided.

Subsection 3.3A. The best of all worlds is for the owner to make the source meet MSHA requirements. Periodic good quality digital photos of the high wall will help document source quality and can help resolve disputes.

Subsection 4.1A. The cubic yard payment has several advantages. Accurate survey equipment now exists to make this practical and avoids quantity assurance problems verifying quantities from belt or loader scales. In addition, the reconciliation process is less problematic during internal audits.

Subsection 4.1B. The 90 to 110 percent range for acceptable quantity was established to reduce bidding contingencies associated with not getting paid for the quantity that was actually crushed.

Subsection 4.2A. The payment adjustment factor may be the most important part of this specification for both the County and the Contractor. Marginally qualified Contractors or those that traditionally bid low and submit numerous claims typically bid higher because the acceptance process for out of spec products is not negotiable.

Subsection 4.2B. The five percent bonus for good stockpiling techniques/equipment was added to reflect the benefits of reduced segregation

Spec Subsection references that refer to the drawings:

Subsection 3.1A. Pit plan drawings should show stockpile locations for top soil, overburden and crushed aggregate.

Subsection 3.2A, C & D: Pit plan drawings should include the following: mining area boundaries, vertical and horizontal excavation limits, clay or other additive stockpile location (if applicable), cross sections through each test pit location and test data, as well as stripping depths for top soil and overburden that will ensure the project quantities and County source utilization objectives will be met.

Subsection 3.3: Pit reclamation requirements- indicate if high wall is to be removed or left in place for later removal and reclamation by County.

Make % Fracture higher and raise PI plus minus #200 by 5%

Optional Table 1 for Rockier Gravel Pits with Higher Fracture

Pay Adjustment Factor (PAF)	1.05	1.00	0.95	0.75	0.50	0.00
Sieve Size	% Passing					
1 inch	100	100	100	100	100	
1/2 inch (8)	70-80	68-82	66-84	64-86	62-88	<62 or >88
No. 4 (6)	38-52	36-54	34-56	32-58	30-60	<30 or >60
No. 40 (3)	15-25	13-27	12-26	11-27	10-28	<10 or >28
No 200 (2)	8-14	6-16	6-17	6-18	5-19	<5 or >19
% Fracture, one face, min (15)	75	70	60	55	50	<50
Plasticity Index (5)	4-10	5-9	3-10	0-10	0-12	0 or >12
Sum of Plasticity Index plus Percent Passing #200, max (a)	20	20	22	24	26	>26

(a) As an example, if PI is 6, percent passing #200 must not exceed 14 to achieve 1.05 Pay Factor

() Values within parenthesis are maximum allowable differences between Consultant & Contractor test results

Gradation, % Fracture & PI in column for PAF=1.0 is from FHWA Minuteman Missile Base Roads

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PART 1: GENERAL

1.1 DESCRIPTION

- A. This work is the crushing and stockpiling of gravel road surfacing aggregate composed of crushed gravel, stone or other similar materials meeting the gradation and other quality criteria specified herein.

1.2 REFERENCES

- AASHTO T2 Sampling of Aggregates
- AASHTO T11 Amount Finer than No 200 (0.075mm) Sieve in Aggregate
- AASHTO T27 Sieve Analysis of Fine and Coarse Aggregates
- AASHTO T89 Determining Liquid Limit of Soils
- AASHTO T 90 Determining the Plastic Limit and Plasticity Index of Soils
- AASHTO T248 Reducing Samples of Aggregate to Testing Size
- ASTM D5821 Determining the Percentage of Fractured Particles in Coarse Aggregate

PART 2: PRODUCT

2.1 CRUSHED SURFACE MATERIAL QUALITY

- A. Furnish crushed aggregate that meets requirements in TABLE 1 Section 2.2A.
- B. Provide fine and coarse fragments of crushed stone or crushed gravel and/or natural gravel, and when approved, blended with sand or clay, finely crushed stone, crusher screenings, recycled concrete and/or asphalt or other similar materials.
- C. Use crushed stone or gravel consisting of hard, durable particles or fragments of stone, free of excess flat, elongated, soft or disintegrated pieces, or other deleterious matter.

2.2 GRADATION, PLASTICITY AND PERCENT FRACTURE

- A. Furnish material meeting requirements in TABLE 1 below

TABLE 1. GRADATION, % FRACTURE and PLASTICITY INDEX

Pay Adjustment Factor	1.05	1.00	0.95	0.75	0.50	0.00
Sieve Size	% Passing					
5/8 inch	100	100	100	100	100	
3/8 inch (8)	69-81	67-83	65-85	63-87	61-89	<61 or >89
No. 4 (6)	50-66	48-68	46-70	44-72	42-74	<42 or >74
No 16 (4)	27-40	25-42	23-44	21-46	19-48	<19 or >48
No. 40 (3)	19-28	17-30	15-32	13-34	11-36	<11 or >36
No 200 (2)	10-16	8-18	7-19	6-20	5-20	<5 or >20
% Fracture, one face, min (15)	75	65	60	55	50	<50
Plasticity Index (5)	4-10	4-10	2-10	0-10	0-12	0 or >12
Sum of Plasticity Index plus Percent Passing #200, max (a)	20	20	22	24	26	>26

(a) As an example, if PI is 6, percent passing #200 must not exceed 14 to achieve 1.05 Pay Factor

() Values within parenthesis are maximum allowable differences between Consultant & Contractor test results

- B. Suitability of aggregate is based on the average of all daily acceptance samples obtained during crushing.
- C. Prior to crushing, demonstrate all sampling, splitting and testing to be done on site. Provide contact information for any testing to be done by consultants off-site

2.3 SAMPLING, SAMPLE PREPARATION AND TESTING

- A. Build a daily sampling stockpile by taking full bucket load samples every 2 hours during crushing. When stockpiling with fixed rotary conveyors sample from the fresh pile face. When stockpiling with a telescoping rotary stacking conveyor sample by diverting the stream to fill up a loader bucket. If more than one shift is worked each day, build a daily sampling stockpile for each shift. At the end of the day (or shift) mix the sampling stockpile with the front end loader, and then flatten to a 12 to 15 inch thick layer by back dragging the bucket cutting edge. Take a composite daily (or shift) acceptance sample from eight to ten random locations on the flattened surface such that a sample of at least 150 lbs. is available for splitting to testing size. If a County representative is not present during sampling at the end of the day, take a photo of the flattened stockpile sampling area with a camera that is programmed to record date and time of day photo was taken. Email this photo to the Engineer. If crushing takes place for under four hours, postpone composite sampling until the following day (or shift) when more material is crushed.
- B. Provide and utilize an on-site testing trailer equipped with sampling and testing equipment for running tests on quality control samples. Split acceptance samples in accordance with AASHTO T248 to testing size using a mechanical splitter. Provide two sample splits to the County for acceptance testing in containers meeting AASHTO T2 requirements. Test one of the other sample splits immediately so that timely adjustments can be made to the crushing operation, source utilization, etc. to ensure future materials are within specification limits. Save at least two sample splits until final payment for “retesting” if that becomes necessary. Label each sample with sample number, date and time sample was taken and tonnage from belt scale totalizer (if available).
- C. Stop crushing and submit a written plan detailing operational changes when the following occurs:
 - a. Pay adjustment factor becomes less than 1.0
 - b. Contractor and County Consultant test results are not within maximum allowable differences shown in parenthesis in Table 1.

PART 3: EXECUTION

3.1 STOCKPILE SITE PERPARATIONAND STOCKPILING

- A. Strip top soil and overburden and stockpile separately unless otherwise indicated on the drawings. Clear stockpile sites of weeds, roots, stumps, large rock and other contaminating matter. Dispose of this material as directed. Make the stockpile floor firm, smooth, well drained, uniform in cross-section, and able to support the stockpile. Water and compact the stockpile floor to prevent rutting and settlement and where filling is necessary, place and compact material in layers no greater than in eight inch depths. Place a four inch thick layer of one inch minus crushed aggregate on the floor to reduce stockpile contamination. Contact County representative to perform a survey of the floor prior to crushing gravel for payment.
- B. Stockpile with equipment and by methods that control segregation, degradation and contamination. When conveyor stockpiling allows gravel to run down stockpile surface more than five feet, add 500 gallons of water for every 100 tons of aggregate produced. If using trucks or front end loaders to stockpile do not dump or push material over the stockpile sides. Maximum conveyor drop height is six feet.

3.2 CRUSHING.

- A. (Option I) Uniformly add clay in the amount needed during crushing to meet plasticity index and gradation requirements. In no case can the final product contain more than five percent clay lumps retained on the No. 4 sieve. The plasticity index requirement can also be achieved by adding processed clay or bentonite from private offsite sources.
- A. (Option II) If necessary, add offsite clay or processed bentonite to meet plasticity index specifications.
- A. (Option III) While crushing and stockpiling aggregate, load, haul and uniformly add stockpiled clay shown on the drawings at a rate between 4 and 6 percent by weight of dry aggregate.
- A. (Option IV) Subsection Deleted
- B. Utilize necessary methods and equipment to meet gradation and percent fracture requirements such as reducing production rates, tertiary stage crushing, additional screening capacity, etc.
- C. The quality of material in provided sources is acceptable in general, but may contain layers or pockets of unacceptable materials. It is not feasible to ascertain from samples the quality of materials for an entire deposit, and variations may be expected. Materials source investigation data is available upon request, including sample site locations, depth of samples, and test results. The contractor must determine the quantity and type of equipment and work necessary to produce acceptable materials. Private off site gravel sources may be used that meet specifications provided the crushed gravel is stockpiled at location(s) indicated in the contract documents.
- D. Stay within the mining area staked on the ground and cross sections shown on the drawings for agency provided sources. Comply with all mining area requirements shown on the drawings.
- E. Calculate pay adjustment factors immediately after receiving acceptance sample test results.

3.3 PIT RECLAMATION.

- A. Unless noted otherwise on the drawings reclaim pit and remove high wall under the direction of a County representative. Prearrange date(s) for reclamation so that the County representative can be onsite.

PART 4: MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. Determine cubic yard quantities of crushed surfacing by employing a licensed surveyor to conduct measurements by GPS rover with base station or high definition scanning with point cloud data after the stockpile floor has been completed and again after specified quantities have been stockpiled. Provide all survey data to the County for verification.
- B. Cubic Yard quantities between 90 and 110 percent of the specified quantities will be paid for according to the quantities determined as indicated above. No payment will be made for quantities exceeding 110 percent of the specified quantity.

4.2 PAYMENT.

- A. A. Payment is determined by multiplying the payment adjustment factor (See Table 1 in Subsection 2.2) times the unit price times the total cubic yard quantity determined under Subsection 4.1 MEASUREMENT. The payment adjustment factor is determined by (1) averaging all of the composite daily (or shift) acceptance sample test results, (2) determining which column in Table 1 is met by the average test results and (3) selecting the pay adjustment factor at the top of that column.
- B. Final payment will be increased by five percent when:
 - a. Telescoping rotary stacking conveyors (“TeleStacker®” by Superior Industries or equal) are used for stockpiling, or
 - b. Stockpiles are built in three or more layers.