SECTION 1033 -- AGGREGATES

1033.01 -- Description

1. Mineral aggregates shall be crushed rock, broken stone, gravel, sand-gravel, coarse sand, fine sand, or a mixture of these materials composed of clean, hard, durable, and uncoated particles. Crushed rock shall be crushed limestone, dolomite, granite, quartzite, or other ledge rock approved for the intended purpose by the Department's Materials and Research Engineer.

2. This combined aggregate gradation using Class R aggregate is to optimize aggregate blends utilizing more locally available materials.

a. Achieving a uniform gradation for Class R may require the use of two or more different aggregates. It is the responsibility of the contractor to meet additional material characteristics requirements; such as, but not limited to particle shape, cubicity, angularity, etc., when designing a mix.

1033.02 -- Material Characteristics

1. Sampling and Testing Procedures:

a. All materials shall be sampled and tested in accordance with Table 1033.01. All material source locations and quarries must be approved by the Department prior to use.

Table 1033.01

Sampling and Testing Procedures	
Procedure	**Method**
Sampling	NDOT T 2
Sieve Analysis	NDOT T 27
Clay Lumps, Shale, and Soft Particles	NDOT T 504
Abrasion	AASHTO T 96
Freeze and Thaw Soundness	NDOT T 103
Specific Gravity and Absorption (course aggregate)	AASHTO T 85
Specific Gravity and Absorption (fine aggregate)	AASHTO T 84
Total Evaporable Moisture Content of Aggregates by Drying	AASHTO T 255
Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test	AASHTO T 176
Sodium Sulfate Soundness	AASHTO T 104
Calcium Carbonate	NDOT C 25
Organic Impurities	AASHTO T 21
Mortar-Making Properties=	AASHTO T 71
Reducing Field Samples of Aggregate to Testing Size	AASHTO T 248
Lightweight Pieces in Aggregates	NDOT T 113

2. General Aggregate Properties:

a. Aggregates shall be free from injurious quantities of dust, soft or flaky particles, loams, alkali, organic matter, paper, wood, or other deleterious matter as determined by the Engineer.

b. Dolomite as herein defined is a magnesium limestone containing calcium carbonate and magnesium carbonate in approximately a 4 to 3 ratio.

c. The calcium carbonate content of limestone shall be at least 80% (computed as $CaCO_3$ from the value determined for CaO).

d. Fine sand shall have at least 95% of its particles pass the No. 10 (2.0 mm) sieve and no more than 25% pass the No. 200 (75 μm) sieve. This definition applies to the sodium sulfate soundness test.

e. Once an aggregate's soundness and abrasion quality has been determined, additional quality testing for soundness and abrasion loss will be at the Engineer's discretion.

f. All aggregates or combined aggregates that have been washed or coming from a wet pit shall be stockpiled for a minimum of 48 hours before being introduced into concrete.

3. Portland Cement Concrete Aggregate:

a. Fine Aggregate:

(1) Aggregate shall be washed and composed of clean, hard, durable and uncoated particles.

(2) Aggregates produced from wet pits by pumping must be adequately washed by means approved by the Department.

(3) Aggregates from dry pits shall be adequately washed by means approved by the Department and have a Sand Equivalent value not less than 90 in accordance with AASHTO T 176.

(i) If the Sand Equivalent is less than 90, the Engineer may elect to stop aggregate production until such a time ASTM C 109 has been completed. The aggregate, when subjected to the test for mortar-making properties, shall produce a mortar having a compressive strength at the age of 7 days equal to or greater than that developed by mortar of the same proportions and consistency made of the same cement and aggregate after the aggregate has been washed to a sand equivalent greater than 90. Materials failing to produce equal or greater strength shall be unacceptable.

(4) Aggregate for concrete shall have a soundness loss of not more than 10% by weight at the end of 5 cycles using Sodium Sulfate Soundness test AASHTO T 104.

(5) The weight of the aggregate shall not contain more than 0.5% clay lumps.

(6) Aggregate subjected to the colorimetric test for organic impurities which produces a color darker than the standard shall be further tested for its mortar-making properties in accordance with AASHTO T 71. The Engineer may elect to stop aggregate production until such a time AASHTO T 71 testing has been completed.

(i) Aggregate, when subjected to the test for mortar-making properties, shall produce a mortar having a compressive strength at the age of 7 days equal to or greater than that developed by mortar of the same proportions and consistency made of the same cement and aggregate after the aggregate has been treated in a 3% solution of sodium hydroxide. Materials failing to produce equal or greater strength shall be unacceptable,

except when determined to be acceptable under the provisions of Subsection 105.03.

(7) Aggregate shall meet the requirement in Tables 1033.02A, 1033.02B and 1033.03C.

(8) Lightweight pieces (measured by percent by volume values) shall not exceed 3.5%. For Class R aggregate, fine aggregate is defined as any material passing a No. 4 sieve.

Table 1033.02A

AGGREGATE SPECIFICATION RANGE											
Percent Passing											
Percentage		**1½"**	**1"**	**¾"**	**½"**	**3/8**	**No.4**	**No.10**	**No.20**	**No.30**	**No. 200**
Class A	Max	--	--	--	--	**100**	**100**	**90**	--	**40**	**3**
	Min						**92**	**64**		**10**	**0**
Class B	Max	--	**100**	--	--	--	**97**	**70**	--	**40**	**3**
	Min						**77**	**50**		**16**	**0**
Class C	Max	--	**100**	--	--	--	**88**	**50**	--	**20**	**3**
	Min						**44**	**24**		**4**	**0**

Table 1033.02B

Aggregate Classes and Uses	
Aggregate Class	**Concrete Description**
A	Overlay Concrete SF
B	47BD, 47B-HE, 47B-OL, PR 1 and PR 3
C	BX

b. Coarse Aggregate:

(1) Aggregate shall consist of Limestone, Quartzite, Dolomite, Gravel and Granite composed of clean, hard, durable, and uncoated particles.

(2) The percent of clay lumps, shale, or soft particles shall not exceed the following amounts:

Clay Lumps.....	0.5%
Shale.....	1.0%
Soft Particles.....	3.5%
Lightweight Pieces.....	3.5%

(3) Any combination of clay lumps, shale and soft particles (all percent by weight values), plus the lightweight pieces (a % by volume value) shall not exceed 3.5%. For Class R aggregate, coarse aggregate is defined as any materials retained on a No. 4 sieve.

(4) Aggregate for concrete shall be free of coatings that will inhibit bond and free of injurious quantities of loam, alkali, organic matter, thin or laminated pieces, chert, or other deleterious substances as determined by the Engineer.

(5) Aggregate for concrete shall not have a soundness loss greater than 8.0% by weight at the completion of 16 cycles of alternate freezing and thawing.

(6) Aggregates for concrete shall have a Los Angeles Abrasion loss percentage of not more than 40.

(7) All fractions passing the No.4 sieve shall meet quality requirement of soundness loss of not more than 10% by weight at the end of 5 cycles using sodium sulfate solution.

(8) The ledge rock shall be tested according to ASTM C 1260.

(i) The mortar bars for the ASTM C 1260 shall not exceed 0.10% expansion at 28 days.

(a) If the proposed coarse aggregate exceeds 0.10% expansion at 28 days, the aggregate proportions used on the project shall be tested in accordance to ASTM C 1567.

i. The ASTM C 1567 mortar bars shall be composed of Interground/blended cement being used on the project.

ii. If the expansion is greater than 0.10%, the coarse aggregate shall not be used.

(9) Aggregate shall meet the requirements in Tables 1033.03A, B, and C.

Table 1033.03A

Aggregate Specification Range											
Percent Passing											
Percentage		**1½"**	**1"**	**¾"**	**½"**	**3/8**	**No.4**	**No. 10**	**No. 20**	**No. 30**	**No. 200**
Class E	Max Min	**100**	**100 92**	**90 66**	**--**	**45 15**	**12 0**	**--**	***4 0**	**--**	**3 0**
Class F	Max Min	**--**	**--**	**100**	**100 96**	**90 40**	**30 4**	**8 0**	**--**	**--**	**3 0**

*If the No. 200 sieve is less than 1.5% passing, the No.20 sieve could be increased to maximum of 6% passing.

Table 1033.03B

Aggregate Classes and Uses	
Aggregate Class	**Concrete Description**
E	47BD, 47B-HE, PR 1 and PR 3
F	47B-OL, Overlay Concrete SF

c. Combined Aggregates:

(1) The Contractor shall design and meet the specification requirements. It is the Contractor's responsibility to provide desirable mix properties; such as, but not limited to, workability, resistance to segregation, stable air void system, good finishing properties and good consolidation properties.

(2) The combined blended aggregate shall meet the requirement in Table 1033.03C and 1033.03D.

Table 1033.03C

*Class R - Combined Aggregate Gradation Limits (Percent Passing)								
Sieve Size	**1 ½ inch**	**1 inch**	**3/4 inch**	**No.4**	**No.10**	**No.30**	**No. 50**	**No. 200**
Max	100	100	98.0	70.0	50.0	30.0	12.0	3.0
Min	-	92.0	85.0	45.0	31.0	8.0	2.0	0

***** Refer to Subsection 1002.04, Paragraph 1.b.(8) for the traditional 47B Mix Design

Table 1033.03D

Aggregate Classes and Uses	
Aggregate Class	**Concrete Description**
R	47B

d. Aggregate Production and Testing:

(1) Any change greater than 3% in the original verified constituent percentage of the combined aggregates gradation will be considered non-compliant. Any change of the combined gradation targets must remain within the Combined Aggregate Gradation Limits in Table 1033.03C. The Contractor shall resubmit a new mix design if the material is deemed non-compliant in accordance with Subsection 1002.04, Paragraph 1.

(2) The blended gradation tolerance ranges from the approved mix design are established in Table 1033.03E.

(i) The Contractor shall assume the responsibility to cease operations when the specifications are not met. Production shall not be started again without the approval of the Engineer.

Table 1033.03E

Blended Aggregate Production Tolerances

Sieve Size	Tolerances
No. 4 or greater	± 5%
No. 10 to No. 30	± 4%
No. 50	± 3%
Minus No. 200	± 1%

(3) Ledge rock and aggregate from a dry pit shall be uniformly saturated with water before it is used. The wetting shall begin 24 hours before concrete mixing to allow complete saturation.

4. **Bituminous Aggregate:**

Table 1033.04A

Asphalt Combined Aggregate Grading Band Tolerance		
Band "A" Mix [1/2 inch (12.5 mm)] [To Be Used When Total Thickness Is 4 Inches (100 mm) Or Less]		
	% Passing	
Sieve Size	**Min.**	**Max.**
1 inch (25.0 mm)	100%	
3/4 inch (19.0 mm)	98%	100%
1/2 inch (12.5 mm)	94%	100%
3/8 inch (9.50 mm)	80%	98%
No. 4 (4.75 mm)	52%	88%
No. 10 (2.00 mm)	32%	70%
No. 30 (600 μm)	17%	38%
No. 50 (300 μm)	10%	24%
No. 200 (75 μm)	3%	7%

Table 1033.04B

Asphalt Combined Aggregate Grading Band Tolerance		
Band "B" Mix [3/4 inch (19 mm)] [To Be Used When Total Thickness Is Greater than 4 Inches (100 mm)]		
	% Passing	
Sieve Size	**Min.**	**Max.**
1 inch (25.0 mm)	100%	
3/4 inch (19.0 mm)	98%	100%
1/2 inch (12.5 mm)	76%	93%
3/8 inch (9.5 mm)	60%	88%
No. 4 (4.75 mm)	42%	78%
No. 10 (2.00 mm)	27%	60%
No. 30 (600 μm)	14%	38%
No. 50 (300 μm)	8%	21%
No. 200 (75 μm)	3%	7%

a. Bituminous aggregate shall have the following characteristics:

(1) Aggregate shall meet the requirements in Tables 1033.04A and B.

(2) The combined aggregate's compliance shall be tested on an individual aggregate basis.

(3) Tests to determine compliance with the quality requirements for gravel shall be performed on the "Pre-Crushed" gradation.

(4) Crushed rock for asphaltic concrete shall not contain deleterious substances in a quantity to exceed the following percentage by weight:

Clay Lumps and Shale.....1.5
Soft Particles.....3.5

(5) Any combination of shale, clay, or soft particles shall not exceed 3.5% by weight.

(6) All fractions of a crushed rock gradation shall be produced from the same type of material. The chemical and physical characteristics of the fraction passing the No. 4 (4.75 mm) sieve shall be substantially the same as those of the material which may be produced in the laboratory from the fraction which is retained on the No. 4 (4.75 mm) sieve. Crushed rock for asphaltic concrete shall have a percentage loss of not more than 8.0% by mass at the end of 16 cycles of the freezing and thawing test.

(7) Quality:

(i) When any fraction of a mineral aggregate, except for crushed rock for use in asphaltic concrete, is of a nature adapted for the Los Angeles Abrasion Test, it shall have a loss percentage of not more than 40.

(ii) Mineral aggregates, except for crushed rock for asphaltic concrete, shall have a soundness loss of not more than 12% by weight at the end of 5 cycles using sodium sulfate solution.

(8) Quartzite, granite, and chat used in Asphalt Concrete shall have a soundness loss of not more than 12 % by weight at the end of 5 cycles using sodium sulfate solution. The Los Angeles Abrasion Test shall have a loss percentage of not more than 40, and the "D" Grading is void.

(9) Maximum percentages established for limestone exclude recycled materials.

b. Soil type mineral filler, fly-ash mineral filler, or limestone dust which is produced as a by-product of sugar beet refining will not be allowed.

c. Mineral filler shall consist of pulverized crushed rock, broken stone, gravel, sand-gravel, sand, or a mixture of these materials that conforms to the following requirements:

	Min.	Max.
Total Percent Passing the No. 50 (300 μm) Sieve	95	100
Total Percent Passing the No. 200 (75 μm) Sieve	80	100
Plasticity Index [material passing the No. 200 (75 μm) Sieve]	0	3

d. At the start of production, one sample of mineral filler will be analyzed for its properties by the Department's Materials and Research Laboratory. If the sample is approved, no further tests will be required for the project. If the sample fails to meet the requirements, then further tests will be required.

e. When determining the maximum percentage of limestone in the mix, the recycled materials will not be considered.

5. **Bituminous Sand Aggregate:**

Table 1033.05

Bituminous Sand Aggregate Gradation Limits		
	Percent Passing	
Sieve Size	**Min.**	**Max.**
3/8 inch (9.50 mm)	---	---
No. 4 (4.75 mm)	---	---
No. 10 (2.00 mm)	---	---
No. 50 (300 μm)	100	60
No. 200 (75 μm)	33	12

a. Cold-mixed bituminous mixtures shall consist of approved inert mineral matter.

b. If soil type filler is approved for use, it shall be pulverized to the extent that 100% will pass the 1/2 inch (12.5 mm) sieve and at least 90% will pass the No. 10 (2.00 mm) sieve before combining with other aggregates.

c. Aggregate shall meet the requirements in Table 1033.05.

6. **Surfacing Aggregates:**

a. Gravel aggregate for surfacing shall have a Los Angeles Abrasion loss percentage of not more than 40.

b. Gravel aggregate for surfacing shall have a soundness loss of not more than 12% by weight at the end of 5 cycles using sodium sulfate solution.

c. Aggregate shall meet requirements in Table 1033.06 or 1033.07, as applicable.

Table 1033.06

Gravel Surfacing Gradation Limits		
	Percent Passing	
Sieve Size	**Target Value**	**Tolerance**
1 inch (25.0 mm)	100	0
No. 4 (4.75 mm)	78	±17
No. 10 (2.00 mm)	16	*
No. 50 (300 μm)	---	---
No. 200 (75 μm)	3	±3

* A deduction from contract bid price will be made as specified in Section 310, Table 310.01.

d. The gravel aggregates for surfacing shall have a Los Angeles Abrasion loss percentage of not more than 40.

e. Gravel aggregates for surfacing shall have a soundness loss of not more than 12% by weight at the end of 5 cycles using sodium sulfate solution.

Table 1033.07

Crushed Rock for Surfacing Gradation Limits		
	Percent Passing	
Sieve Size	Target Value	Tolerance
1 inch (25.00 mm)	100	0
No. 4 (4.75 mm)	40	±20
No. 10 (2.00 mm)	15	±15
No. 50 (300 μm)	---	---
No. 200 (75 μm)	5	±5

f. Crushed rock for surfacing shall consist of clean, hard particles of crushed limestone, quartzite, or dolomite.

g. Crushed rock for surfacing shall have a Los Angeles Abrasion loss percentage of not more than 45.

h. Crushed rock for surfacing shall have a percent loss of not more than 30 at the end of 16 cycles of the freezing and thawing test.

7. **Base Course:**

Table 1033.08

Crushed Rock				
	Crushed Rock for Base Course		Crushed Rock Screenings for Base Course	
	Percent Passing			
Sieve Size	Target Value	Tolerance	Target Value	Tolerance
1 1/2 inch (37.5 mm)	100	0		
3/4 inch (19.0 mm)	80	±15	100	0
3/8 inch (9.50 mm)	53	±17	73	±17
No. 4 (4.75 mm)	---	---	55	±15
No. 10 (2.00 mm)	20	±10	---	---
No. 20 (850 μm)	---	---	28	±12
No. 200 (75 μm)	5	±5	13	±7

a. Base Course Aggregate shall be crushed rock or broken stone or a mixture of these materials composed of clean, hard, durable, and uncoated particles.

b. Quality:

(1) Crushed rock shall be crushed limestone, dolomite, granite, quartzite, or other ledge rock approved for the intended purpose by the Department's Materials and Research Engineer.

(2) Dolomite as herein defined is a magnesium limestone containing calcium carbonate and magnesium carbonate in approximately a 4 to 3 ratio.

(3) All sizes of crushed rock for base course shall be produced from the same type of material. The chemical and physical characteristics of the fraction passing the No. 4 (4.75 mm) sieve shall be substantially the same as those of the material which may be produced in the laboratory from the fraction which is retained on the No. 4 (4.75 mm) sieve.

(4) Crushed rock for base course shall not contain shale, clay lumps, or other deleterious substances in a quantity to exceed a total of 2.5% based on the dry mass of the fraction retained on the No. 4 (4.75 mm) sieve.

(5) Crushed rock for base course shall be free from injurious quantities of dust, soft or flaky particles, loams, alkali, organic matter, paper, wood, or other deleterious material.

(6) The Los Angeles Abrasion loss percentage shall not exceed 45.

(7) Crushed rock for base course shall have a percentage loss of not more than 14 at the end of 16 cycles of the freezing and thawing test.

(8) The absorption of crushed rock for a base course shall not exceed 5.0% by weight.

(9) The product of the plasticity index (using wet preparation AASHTO T 146) of the fraction of the crushed rock for base course passing the No. 40 (425 μm) sieve and the percent of the crushed rock passing the No. 200 (75 μm) sieve shall not exceed 48. When the fraction of the crushed rock for a base course passing the No. 200 (75 μm) sieve does not exceed 4%, the plasticity index will not be determined and the product of the plasticity index and the percent passing the No. 200 (75 μm) sieve will not be a requirement for such material.

(10) The plasticity index (using dry preparation AASHTO T 87) of the crushed rock screenings passing the No. 40 (425 μm) sieve shall not exceed 4.

c. Crushed rock shall meet gradation requirements in Table 1033.08.

8. **Foundation Course:**

Table 1033.09

Foundation Course Mixture		
	Percent Passing	
Sieve Size	**Target Value**	**Tolerance**
1 inch (25.0 mm)	100	0
No. 10 (2.00 mm)	62	+12
No. 40 (425 μm)	34	±8
No. 200 (75 μm)	9	±3

Table 1033.10

Crushed Concrete Foundation Course Gradation Requirements		
Sieve Size	**Target Value (Percent Passing)**	**Tolerance**
1 1/4 inch (31.5 mm)	100	0
1 inch (25.0 mm)	95	± 5
3/4 inch (19.0 mm)	81	±12
No. 4 (4.75 mm)	38	±12
No. 10 (2.00 mm)	24	±11
No. 40 (425 μm)	9	± 5
No. 200 (75 μm)	3	± 3

a. Soil binder from local pits shall be pulverized to the extent that at least 90% will pass a 1/2 inch (12.5 mm) sieve and at least 60% will pass a No. 10 (2.00 mm) sieve. The binder shall be pulverized before it is mixed with the other aggregates.

b. Any fraction of a mineral aggregate is of a nature adapted for the Los Angeles Abrasion Test, the loss percentage shall not be more than 40.

c. Mineral aggregates shall have a soundness loss of not more than 12% by weight at the end of 5 cycles using sodium sulfate solution.

d. Foundation course material shall meet the requirements in Table 1033.09 or 1033.10, as applicable.

1033.03 -- Procedures

1. Freshly washed or pumped aggregates shall be drained for 12 hours before use.

2. Protection of Material:

a. It is the Contractor's responsibility to protect materials from harmful contamination, segregation, excessive degradation, or other changes in the physical or chemical state or degree of uniformity.

b. If any detrimental change has taken place in the materials after the acceptance samples have been taken and tested, the right is reserved to retest and reject that part of the previously accepted material which is found unsatisfactory or require the Contractor to correct the deficiencies by reprocessing or providing other material meeting specification requirements.

3. Handling of Material:

a. The use of crawler-type equipment will be allowed in the stockpiling of fine aggregate and sand gravel aggregates.

b. Aggregate shall be removed from stockpiles with cranes, loaders, conveyors, or other approved equipment.

c. The use of crawler equipped dozers or end loaders will not be allowed in the stockpiling or the removal of crushed rock aggregates if the aggregate is damaged by the equipment.

4. Care shall be exercised to avoid segregation or degradation of aggregates or the inclusion of foreign material in the aggregates while they are being removed from the stockpiles.

5. Storage of Material:

a. Each aggregate that is to be stockpiled, either at the producer's plant or at the site of the work, shall be stockpiled separately.

b. Similar materials from different sources of supply shall not be mixed or stored in the same pile or used alternately in the same class of construction or mix without permission from the Engineer.

c. Materials which become intermixed (i.e., with other sources or different gradations) or which become contaminated by foreign materials shall not be used.

d. Aggregates shall not be stockpiled against the supports of proportioning devices or scales.

6. Properly drained aggregates unloaded and handled by conveyor systems may be deposited directly into the batch hoppers provided the equipment and procedures used will furnish aggregate of uniform gradation and moisture content.

7. It shall be the obligation of the contractor or concrete producer to maintain a uniform gradation and moisture content in each aggregate used during the handling and batching operations.

8. Similar materials produced by pumping from different pits in the Platte River Valley shall be considered to be from the same source.

1033.04 -- Acceptance Requirements

1. Aggregates will be accepted based on the requirements of this Section and sampling and testing requirements as described in the Department's *Materials Sampling Guide*.