

CHAPTER 2

AGGREGATES

2-1. Options. Materials for concrete paving may be crushed or uncrushed gravel, crushed stone, crushed blast-furnace slag, or recycled crushed PCC pavement for coarse aggregate; or natural or manufactured sand for fine aggregate.

2-2. Sources. Aggregate material should be sought in the area or vicinity of the project. Distant sources could incur transportation problems since freight train or long distance trucking would be required. The advice of local suppliers, contractors, or engineers should be sought to evaluate the optimal source of concrete aggregates.

2-3. Coarse aggregate.

a. Composition. The crushing of gravel or stone tends to improve quality and bond characteristics and generally results in a higher flexural strength of concrete. When mixture proportioning studies or local experience indicates that a low flexural strength will be obtained with uncrushed gravel or stone, the possibility of obtaining higher strength by crushing the material will be investigated.

b. Size and grading. The nominal maximum size of the coarse aggregate used in pavement concrete should not exceed 1/4 of the pavement thickness. In no case will the coarse aggregate exceed a 2-inch nominal maximum size. When the nominal maximum size of coarse aggregate is greater than 1 inch, the aggregates will be furnished in two size groups as shown in table 2-1, with gradings within the separated size groups conforming to the requirements of table 2-2. Where local practice provides size-group separations other than shown in table 2-1, local size gradings may be specified if approximately the same size ranges are obtained and the grading of coarse aggregate when combined and batched for concrete is as required by mixture proportioning. State specifications for gradings may be used in place of the Corps of Engineers gradings.

Table 2-1. Coarse Aggregate Size Groups

<u>Maximum Nominal Size</u>	<u>Size Groups</u>
1-1/2 in.	No. 4 to 3/4 in. 3/4 in. to 1-1/2 in.
2 in.	No. 4 to 1 in. 1 in. to 2 in.

Table 2-2. Grading of Coarse Aggregate

Sieve Size U. S. Standard Square Mesh	Percentage by Weight Passing Individual Sieves			
	No. 4 to 3/4 in.	No. 4 to 1 in.	3/4 in. to 1-1/2 in.	1 in. to 2 in.
2-1/2 in.				100
2 in.			100	97 ± 3
1-1/2 in.		100	95 ± 5	50 ± 20
1 in.	100	97 ± 3	37 ± 17	7 ± 7
3/4 in.	95 ± 5	---	7 ± 7	---
1/2 in.	---	43 ± 20	---	3 ± 3
3/8 in.	37 ± 17	---	3 ± 3	
No. 4	5 ± 5	5 ± 5		
No. 8	3 ± 3	3 ± 3		

c. Deleterious substances. Deleterious substances in coarse aggregate are unintended materials contaminating the desired aggregate. These substances will reduce concrete strengths, increase the chance for popouts and weatherouts, decrease workability of the plastic concrete, and lead to abbreviated life spans of the concrete pavements. Time will not allow extensive testing of aggregate stockpiles, but if deleterious substances are suspected, washing of the aggregate should be specified. This should take care of most of the objectionable material. If unwanted materials are still present and to such a degree as to cause considerable problems, a new source for aggregate should be sought. Some deleterious substances which are possible in concrete aggregates are listed in table 2-3. The amounts of these substances in each size group of coarse aggregate should not exceed the limits shown, determined in accordance with ASTM C 117, ASTM C 123, ASTM C 295 applicable only to material coarser than 3/8 inch, and ASTM C 142.

Table 2-3. Deleterious Substances in Coarse Aggregate

<u>Materials</u>	<u>Percentage by Weight</u>
Clay lumps	2.0
Shale	1.0
Material finer than No. 200 sieve	1.0

Table 2-3. Deleterious Substances in Coarse Aggregate (continued)

<u>Materials</u>	<u>Percentage by Weight</u>
Lightweight particles	0.5
Clay ironstone	1.0
Chert and/or cherty stone (less than 2.50 sp. gr. SSD)	1.0
Claystone, mudstone, and/or siltstone	1.0
Shaly and/or argillaceous limestone	1.0
Other soft particles	1.0
Total of all deleterious substances exclusive of material finer than No. 200 sieve	3.0

d. Slag aggregate. Before blast-furnace slag is used in concrete, stockpiles of the material must be saturated with water for at least 24 hours.

2-4. Fine aggregate.

a. Composition and shape. Fine aggregate will consist of natural sand, manufactured sand, or a combination of the two, and will be composed of clean, hard, durable particles. Particles of the fine aggregate should be generally spherical or cubical in shape insofar as practicable. The use of fine aggregate containing flat or elongated particles should be held to a minimum or when no other choice is available. Care must be taken to insure that contaminating substances are not present in fine aggregate stockpiles. Such substances would include dirt, dust, mud, and construction debris.

b. Gradation and uniformity. The grading and uniformity specified in table 2-4 for the fine aggregate are desirable for concrete pavement and can generally be met at reasonable cost with minimum time delays. However, if these requirements create delays detrimental to the intent of the mobilization construction, the specification should be relaxed to provide for conformance with the 3/8 inch and No. 100 sieves only.

Table 2-4. Grading of Fine Aggregate

<u>Sieve Size, U. S. Standard Square Mesh</u>	<u>Cumulative Percentage by Weight Passing Individual Sieves</u>
3/8 in.	100

Table 2-4. Grading of Fine Aggregate (continued)

<u>Sieve Size, U. S. Standard Square Mesh</u>	<u>Cumulative Percentage by Weight Passing Individual Sieves</u>
No. 4	97 \pm 3
No. 8	85 \pm 5
No. 16	70 \pm 10
No. 30	45 \pm 15
No. 50	20 \pm 10
No. 100	6 \pm 4

Note: In addition, the fine aggregate, as delivered to the mixer, should have a fineness modulus of not less than 2.40 nor more than 2.90. The grading of the fine aggregate also should be controlled so that the fineness moduli of at least nine of ten samples of the fine aggregate as delivered to the mixer will not vary more than 0.15 from the average fineness moduli of all samples previously taken.

c. Deleterious substances in fine aggregate. The amount of deleterious substances in the fine aggregate should not exceed the limits shown in table 2-5.

Table 2-5. Deleterious Substances in Fine Aggregate

<u>Material</u>	<u>Percentage by Weight</u>
Clay lumps and friable particles	1.0
Material finer than No. 200 sieve	3.0
Lightweight particles	0.5

Note: The total of all deleterious materials should not exceed 3.0 percent of the weight of the aggregate.

2-5. Aggregate for calibration hardstands. Calibration hardstands are used by aircraft technicians to calibrate flight instruments with regard to the earth's magnetic field and hence, metallic objects of any kind will distort readings. This includes concrete pavements containing iron oxides or other iron-rich minerals having magnetic properties which will interfere with the operation of the facility. To avoid the inclusion of these substances in the pavement materials, the concrete aggregate proposed for paving calibration hardstands will be

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subjected to petrographic analyses (ASTM C 295) prior to acceptance. Special attention will be given to the existence of magnetite in granites, high-iron minerals in traprock, pyrite in limestone, and free iron or iron oxide in slag aggregate.