The fineness modulus of coarse sand on the Roza division, Yakima project, was reduced by wasting from 20 to 25 percent of the fraction between No. 4 and No. 8 screens. As wasting an excess in parts of the sand is the most common form of processing, the equipment and methods used for this purpose will be discussed in some detail.

On major projects, improvements in sand grading are accomplished by large classifying units arranged in series or series-parallel as may best suit the requirements. Such units may be spiral, rake, bowl, or different types of water scalping tanks or a combination of types. At Hoover Dam, two rake classifiers and one bowl classifier were used in making one finished-sand product. Each of the three bowl classifiers at Grand Coulee Dam separated a different size range, and the fine, medium, and coarse sands thus obtained were recombined to produce a uniform product from pit-run material of very erratic grading, as shown by the diagram at the bottom of figure 76.

There are different types of classifiers suitable for use on the smaller jobs. The equipment described in subsequent paragraphs includes small commercial machines of moderate cost for wet classification and washing and devices for wet screening and for dry screening.

Careful selection of sand processing methods and equipment will frequently avert excessive overexcavation and unnecessary wasting of otherwise usable aggregate. This selection becomes more critical in sources where the availability of sand is marginal with respect to need. The spiral and rake classifiers are most effective as washing and dewatering equipment. They have been adequately used as classifiers in producing an acceptable sand grading, usually when it was necessary to remove the finer sizes. It is very difficult to eliminate excess coarser sizes with such equipment. If the sand is processed only with this type of equipment, the coarse sand sizes may be partially removed by selected screens or carried over with the coarse aggregate into the secondary screening plant and wasted there. The objection to this procedure is that some of the other usable sand sizes are lost as well. Equipment is now available to separate sand feed into several sizes, portions of which can be wasted or saved, and thus it is possible to readily and economically produce sand within close gradation limits.

When processed sand is divided into different size fractions, it is important that it be mixed thoroughly before being batched. Usually, mixing is accomplished in stockpiling and handling operations. When the finished product is stockpiled, the side slopes should be kept flatter than the angle of repose of the sand (a slope of 7 inches per foot is satisfactory) to prevent accumulation of the coarser material at the bottom of the slope. A spray of just enough water to moisten dry-processed sand will

used. Screens with dimensions and slopes as shown in figure 81 handle 7 to 10 cubic yards per hour.

Other problems in sand classification can be solved by variations of this method. To remove only coarse particles, the first screen and the cutting vane and waste chute shown in figure 81 could be used without the second screen. To waste finer material in the intermediate-size range, the No. 12 screen could be replaced with a shorter No. 16 screen, and the openings in the second screen, No. 16, could be reduced by distorting the mesh into a diamond shape. To waste more intermediate-size material, the first screen could be lengthened and more water used on the second screen. Worn or split screens should be promptly replaced.

Availability of improved wet sand classification equipment has led to further simplified fine material processing. Hydraulic sizers, which automatically direct portions of the sand sizers to waste while retaining and combining only the amounts necessary to control the overall grading, are being more frequently used for efficient sand processing. The incorporation of supplemental equipment, such as cyclones, centrifuges, and jigs to separate and retain fine sand sizes which were formerly inadvertently wasted in the washwater, makes it possible to save more of all sizes of sand and thereby increase overall plant processing efficiency.

66. Dry Processing of Sand.—In some localities where sand is naturally dry and water is not economically available for processing, the impracticability of using screens much finer than No. 8 for volume production in dry sand processing has led to development of other methods. During construction of the Colorado River Aqueduct in the southwestern desert, excess fines passing 100 mesh were successfully removed (when the moisture content was well below 1 percent) by specially designed equipment that drew air through thin sheets of sand cascading over a stepped series of steel angles.

Fairly effective control of the coarser part of a sand may be obtained by use of suitably arranged, adjustable baffles placed under the sand screen to deflect undesired portions to waste. Such separation is based on the fact that the coarser material progresses farther along the screen before falling through it.

The tendency of dry sand to segregate in handling, particularly as it is dropped onto stockpiles or into bins, is very much greater than that of moist or wet sand. For this reason special precautions are necessary. At Parker Dam, sand was moistened by spray on the conveyor belt to the stockpile. Although this virtually eliminated segregation, some difficulty was encountered in obtaining uniformly the 5 to 8 percent moisture needed to prevent excessive segregation. On the Colorado River Aqueduct work, segregation of dry sand was held to a practicable minimum by

drainage. Narrow surfaces such as tops of walls and curbs are usually sloped three-eighths of an inch per foot of width; broader surfaces such as walks, roadways, platforms, and decks are sloped approximately one-quarter of an inch per foot. The classes of finish specified for unformed concrete surfaces are designated as U1, U2, U3, and U4. Surface irregularities allowed in each are shown in table 24. A 10-foot straightedge or template is used for detecting irregularities.

(a) *Finish U1*.—This is a screeded finish used on surfaces that will be covered by fill material or concrete and on surfaces of operating platforms on canal structures. It is also the first stage for finishes U2 and U3. The finishing operations consist of leveling and screeding the concrete to produce an even uniform surface. Surplus concrete should be removed immediately after consolidation by striking it off with a sawing motion of the straightedge or template across wood or metal strips that have been set as guides. Where the surface is curved, as in the invert lining of tunnels, a special screed is used. For long, narrow stretches of invert paving or of flat paving, use of a heavy slip form or of a paving and finishing machine is desirable. The slip form is best for sharply curved inverts; the paving and finishing machine is preferable for flat or long-radius cross sections.

(b) *Finish U2*.—This is a floated finish used on all outdoor unformed surfaces unless other finish is specified. It is used on such surfaces as inverts of siphons and flumes; floors of canal structures, spillways, outlet works, and stilling basins; outside decks of power and pumping plants; floors of service tunnels, galleries, sumps, culverts, and temporary diversion conduits; tops of transmission line and bridge piers and of walls, except tops of parapet walls prominently exposed to view; and surfaces of gutters, sidewalks, and outside entrance slabs. It is also applied to bridge floors and to slabs that will be covered with built-up roofing or membrane waterproofing. Floating may be done by hand or power-driven equipment. It should not be started until some stiffening has taken place and the moisture film or shine has disappeared. The floating should work the concrete no more than necessary to produce a surface that is uniform in texture and free of screed marks. If finish U3 is to be applied, the floating should leave a small amount of mortar without excess water at the surface to permit effective troweling. Any necessary cutting or filling should be done during the floating operations. Joints and edges should be finished with edging tools. Tooled edges are often preferable to formed chamfers.

(c) *Finish U3*.—This is a troweled finish used on inside floor slabs of buildings (except those to receive a bonded concrete or terrazzo finish), on tops of parapet walls prominently exposed to view, on concrete surfaces subject to high-velocity flows, and on interior

is stoppered, shaken vigorously, and the contents allowed to settle for 1 hour. One ounce of sediment above the sand is roughly equivalent to 3 percent by weight of clay or silt. The sand may be washed, samples again tested, and the sand approved for use if requirements are fulfilled.

(c) When the test is made for organic impurities in sand (designation 14), it is unnecessary to make an additional test for the approximate quantity of clay and silt. In the test for organic impurities, ½ ounce of sediment at the top of the 7 ounces of sand corresponds roughly with 3 percent by weight of clay or silt. Sedimentation results are obtained in the 3-percent solution of sodium hydroxide much more rapidly than in water.

PERCENTAGE OF AGGREGATE PASSING NO. 200 SCREEN [12]

Designation 16

1. General.—This test outlines the procedure for determining the total quantity of material, contained in the aggregate, passing a No. 200 (74-micrometer) screen.

2. Apparatus.—(a) Two nested screens, the upper screen a No. 16 and the lower a No. 200, both conforming to the requirements of ASTM Designation E 11, "Standard Specification for Wire-Cloth Sieves for Testing Purposes."

(b) A pan or vessel of a size sufficient to contain the sample covered with water and to permit vigorous agitation without loss of any part of the sample or water.

(c) A drying oven of appropriate size capable of maintaining temperature between 212° and 230° F.

(d) A balance accurate within 0.1 percent of the test load at any point within the range of use.

3. Test Sample.—A representative test sample is obtained by a sample splitter or the quartering method (designation 1, sec. 9 or sec. 10) from material which has been mixed thoroughly and which contains sufficient moisture to prevent segregation. The size of the sample should be sufficient to yield not less than the appropriate weight of dried material, as shown in the following tabulation:

Size of aggregate	*Weight, grams*
0 to 3/16 inch (sand)	500 to 1,000
3/16 to 3/8 inch	1,000 to 1,500
3/8 to 3/4 inch	1,500 to 2,000
3/4 to 1½ inches	2,500 to 3,500
Larger than 1½ inches	A sufficient amount to make a representative sample.

[12] Based on ASTM Designation C 117.