CHAPTER 1 STONE AGGREGATES

GENERAL

Stone aggregates serve a wide variety of purposes in the built landscape. Sometimes they are visible as a finish material; at other times they play a less visible supporting role. Aggregates are available in a vast range of colors and sizes for use as mulch or a top dressing. As a support material, they mitigate the movement caused by freeze and thaw cycles, provide stability, and facilitate critical drainage beneath other pavements. Aggregates are often used as a ground cover in place of vegetation where heavy water drainage and flow are likely to result in erosion. Furthermore, they do all of this at a very economic cost compared to other durable materials. People spend a great deal of their lives traveling, parking, or just relaxing on paved surfaces. Rarely do we see the tons of aggregate just beneath the surfaces that support our countless acres of pavement, nor do we fully appreciate that a significant proportion of that same asphalt and concrete is itself

Figure 1-1 Sorted by color and graded by size, stone aggregates offer a wide range of design options.

Figure 1-2 This aggregate installation serves as an economical, low-maintenance solution for good drainage along the foundation wall of a building.

composed of aggregates. Exposed aggregate concrete lets the selected aggregates shine in the spotlight. More often, though, aggregates are an unseen but key constituent of concrete pavements or walls.

Like many landscape construction materials, aggregates are essentially a gift of nature that people have learned to exploit. Some aggregates were deposited by nature, the result of geologic activity such as glaciation or fluvial activity. Other aggregates are crushed by machinery from larger stones into desired size ranges. Unlike the stone we use in walls, steps, and pavements, aggregates were originally randomly deposited, and so they are typically a mix of many stone types rather than a specific single stone, such as granite or limestone.

The construction industry creates an enormous demand for aggregate materials. They serve as key components in:

Pavement base courses
Concrete mixes, both vertical and horizontal
Bituminous mixes
Pervious surface pavements

Landscape mulch and bed dressing
Drainage courses
Construction backfill

CHARACTERISTICS OF AGGREGATE

Aggregates are as hard as stone because they *are* stone. When used in concrete or asphalt pavements, they bring the strength of stone to those composite materials. When concrete or asphalt fails, it is almost never the mineral aggregate components that fail but, rather, the cementitious material that bonds them together. If an asphalt pavement were to be left unattended for several hundred years, all that would remain would be a layer of loose aggregate material.

Aggregates are often specified to be sorted by size, in a process called *grading*. A well-graded aggregate contains individual stones within a specific size range. An ungraded aggregate contains a broader range of sizes. A well-graded aggregate provides better drainage, whereas the *fines* (extremely small particles of aggregate) present in an ungraded aggregate fill a higher percentage of the voids, impeding internal drainage. A completely ungraded aggregate mix may be nearly as impervious as concrete, but it may also provide a much more stable walking or driving surface than a well-graded mix.

Figure 1-3 Serving as a mulch, this well-graded aggregate bed yields effective weed and moisture control.

Figure 1-4 A well-compacted ungraded aggregate surface provides a stable and visually appealing walking surface at a far lower cost than concrete, asphalt, or masonry unit pavers.

Typically, a flexible pavement calls for two subcourses of different aggregates. A graded course of gravel or crushed stone, provided for stability and drainage, may be topped with a finer course like sand to serve as a leveling or setting bed for unit pavers.

Figure 1-5 Adequate leveling and compaction are critical when aggregate is used as a base course supporting other paving materials.

It is important to use filter fabric in this situation to facilitate drainage while preventing the finer sand from infiltrating and clogging the voids in the drainage course below.

Even though aggregates are stone, they do not require skilled masons for installation. This enhances

their overall economy. This does not mean, however, that no special skills or care are required to install aggregates. It is important for installers to accurately level and compact all specified aggregate courses. Also, when aggregates are used in visual applications, the designer must carefully select their color and grain to complement the overall design palette of a specific project.

Although aggregates offer many advantages at an economic price, designers must take certain concerns into account. Gravel and crushed-stone pavements are easily displaced and require ongoing upkeep. They also make snow removal more difficult than more rigid materials, such as concrete or asphalt. Some aggregate surfaces will not adequately support canes, walkers, or wheelchairs and thus do not meet the requirements of the Americans with Disabilities Act (ADA). Also of concern are narrow-heeled shoes and outdoor furniture with thin support legs.

Figure 1-6 This aggregate walkway endures intense urban foot traffic while providing adequate support for the narrow legs of the site furnishings.

STANDARDS

A variety of aggregate types are commonly used in the built environment. Perhaps more than any other material, aggregates are known by local designations that may vary from region to region. Take care to learn the local designations for aggregates wherever you undertake projects. Still, there are some more-or-less universal designations for aggregates.

Sand is a very fine aggregate material composed of silica. It is commonly used in concrete mixes, in bituminous mixes, as a setting bed for unit pavers, and in mortar mixes. Joint sand may be swept into the joints of a flexible pavement system to add stability without sacrificing drainage.

Sand is not a good choice for walkways, driveways, or mulch. It is easily displaced by traffic, wind, and weather; it clings to shoes and tires; and it is extremely popular with neighborhood cats. Beach sand is not suitable for landscape construction, for a variety of reasons. It is often too weathered and rounded from the action of the surf, and it may contain salts that can degrade masonry. Furthermore, the mining of beach sand is not a sound environmental practice. Specifications for sand typically call for ASTM C-33: *Concrete and Bedding Sand*, or ASTM C-144: *Joint Sand* (finer, for pavers) **Torpedo sand** is well suited to many landscape applications. It is a mix of sand plus fine aggregates, with nothing larger than 3/8 inches. It satisfies the criteria set forth in ASTM C-33.

Gravel is a granular aggregate material that may be composed of almost any type of rock or stone. It is usually between 2½ inches and ⅛ inches in size. It may be rounded, if it derives from a marine or fluvial source, or angular if it is a quarried and crushed product.

Bank-run gravel is deposited by nature and is weathered into smooth, rounded shapes. Because of its rounded form, it is less likely to interlock into a stable base course. Nevertheless, this same smoothed surface can be visually appealing, making it suitable for mulches, exposed-aggregate concrete, and other visible applications.

Pea gravel is a specifically graded size range of bank-run gravel. As its name suggests, it is relatively small grained, approximating the size of peas.

Crushed stone is also known as crusher-run stone. Just as its name suggests, crushed stone is produced by mechanically crushing larger stone. Its sharp, angular facets cause it to interlock and give it more stability than bank-run gravel. It is a popular material as a paving base course and is also used for gravel roads and drives, either where impervious pavement is too costly or a more drainage-friendly paving option is desired. Crushed stone is equally useful in concrete and bituminous recipes.

Designers are well advised to acquire and become familiar with their state Department of Transportation

standard roadbed specifications for any project that involves roadways or parking. These stone aggregate specifications have evolved over a lengthy period of time and have been tested in countless miles of roads and highways.

SIZE AND APPLICATIONS

When a specifically graded size range of aggregate mix is required, project specifications must leave little margin for error yet they must also provide for a practical range of variation. The example in the opposite column shows how aggregate size is specified, in this case for use as a paving base course. Note that the size is determined by passing the aggregate mix through a series of decreasing sieve sizes.

Sieve Size	% Passing by Weight
2"	100 *(nothing can be >2")*
¾"	70–100 *(at least 70% must be <¾", all of it could be <¾")*
No. 4	30–80 *(at least 30% must be <¼", but no more than 80% can be <¼")*
No. 50	10–35 *(at least 10% must be <1/50", but no more than 35% can be <1/50")*
No. 200	0–5 *(no fines are desired, but up to 5% of the total weight is permitted to be fine material)*

AGGREGATES AND THE ENVIRONMENT

Sustainable practices increasingly demand that attention be paid to water quality, drainage, and runoff. Aggregates are by nature well-draining materials that facilitate stormwater drainage and percolation into the groundwater, while serving to filter out contaminants. Pervious pavements, as opposed to porous pavements, are essentially impervious materials with voids provided in the surface area to accommodate drainage. To function, the voids must be filled with a granular aggregate material that is carefully formulated to facilitate drainage while providing a safe walking and driving surface for people of all abilities. Even so, all aggregate mixes are prone to accumulate fines and debris over time, resulting in a measurable loss of permeability.

Because stone aggregates are quarried rather than manufactured, they do not require the extremely high temperatures associated with the firing of bricks or the production of Portland cement. Production of crusher-run stone does require heavy machinery, and thus the burning of fossil fuels, but it should be noted that the source stone for crusher-run material is often the byproduct of, or waste from, larger stone quarrying and cutting operations. Thus, the crushing operation can be viewed as recycling this waste into useful construction material. The acquisition of gravel from quarries carries with it some of the same impacts associated with any quarrying or mining activity and calls for thoughtful reclamation of exhausted sites. Lastly, although aggregate is a relatively heavy material to handle and transport, it is regionally available in almost any area and thus reduces transportation cost and fuel use.

The large range of colors offered by aggregates makes satisfying solar reflectance imminently possible. Aggregates are virtually indestructible and offer an extremely long, in-place life cycle. They can also be recycled repeatedly into new applications without any measurable loss of strength or performance.

LEARNING ACTIVITIES

1. Locate the Website for your state's Highway Department or Department of Transportation.
   a. Find and print the standard specification for aggregate roadbeds.
   b. Prepare a brief summary of this specification.
2. Locate and describe examples in your area where aggregates are used for:
   a. Exposed aggregate cast-in-place concrete surfaces
   b. Mulch or top dressing
   c. Erosion control and drainage courses