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Gravel: Combining Materials

Cornell Local Roads Program
New York LTAP Center

COMBINING MATERIALS FOR SATISFACTORY GRADATION

Suppose a particular source has too little silt and clay (is too clean) for gravel surfaces. If a binder soil is readily available, it is possible to blend a satisfactory gradation. Additionally, if a particular gravel has too much silt and clay (is too dirty) for use in gravel bases it is often possible to tap a local source of sand in order to decrease overall percentage of the silt and clay content in a blended mixture. If we know the gradation of two available materials, we can readily determine what, if any, combinations of these sources will produce a suitable gradation.

The mathematics of this calculation can be somewhat complicated but a graphical solution is simple. The following triangular chart is recommended. Each of the three sides of the triangle is divided from 0-100%. One side is labeled **gravel**, one side is labeled **sand**, and the other side is labeled **silt and clay.**

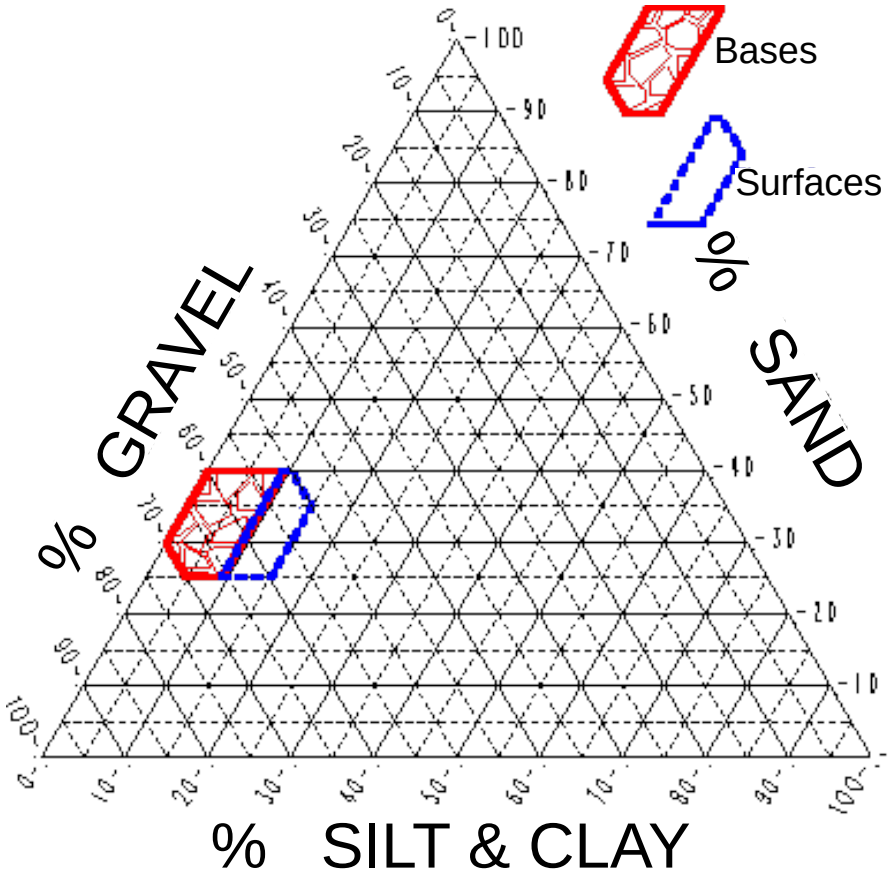

Figure 1:Triagular Textural Chart for Gravel

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As shown in the *Tech Tip* *Gravel: Gradation of Granular Materials*, the dotted area contains all possible combinations of gradations that satisfy the requirements for gravel surface courses. The hatched area represents gradations containing less silt and clay, and hence, suitable for gravel bases.

Suppose we find a gradation of 60% gravel, 28% sand and 12% silt and clay. Plotting this on the chart (point A), we see that the point falls within the dotted area and is suitable, as is, for gravel **surface** courses. A mixture consisting of 65% gravel, 30% sand, and 5% silt and clay (point B) would be suitable for **base** courses.

Let's assume, though, that we have a source that tests 65% gravel, 20% sand, and 15% silt and clay. Plotting this on the chart (point C) we see that it does not meet the requirements for either a base or surface course. Let's assume another source (point D) consist of 10% gravel, 85% sand, and 5% silt. Could C and D be combined to produce a satisfactory gradation of gravel?

Here's how we find out:

Step 1: Plot points C and D (neither falls within the areas of satisfactory gradation)

Step 2: Connect C and D with a straight line. If this line passes through an area of satisfactory gradation, these two materials may be successfully combined. The *only* possible gradations are ones that fall along the line connecting the points. In this case, we can produce a material suitable for a surface course but, by no means, can these two materials produce a blend suitable for a base course.

Step 3: If we want to produce a gradation suitable for a surface course, choose a point on the line near the middle of the dotted area (point *E*)

Step 4: With a ruler or scale, measure the total length of line $\overline{CD}$. Also, measure the length of $\overline{ED}$ and the length of $\overline{CE}$.

$\overline{CD}$	2.20 inches
$\overline{ED}$	0.43 inches
$\overline{CE}$	1.77 inches

Note that the length of $\overline{CE}$ + $\overline{ED}$ = $\overline{CD}$.

Step 5: The percentage of source *D* to get gradation *E* is computed as follows:

$$\%C = \frac{\overline{CE}}{\overline{CD}} \times 100 \qquad \frac{1.77}{2.20} = \times 100 = 80.5\%$$

The percentage of material C to obtain gradation E would be:

100% - D% = 100.0%-17.5% = 82.5%

We can check, though, as follows:

$$\%D = \frac{\overline{ED}}{\overline{CD}} \times 100 \qquad \frac{0.43}{2.20} \times 100 = 19.5\%$$

Step 6: We can generalize by saying that a mixture consisting of about 80% source C and 20% source D will produce a gradation satisfactory for a gravel surface course.

This technique is equally well suited to “cleaning up” a too-dirty gravel source, or conversely, adding binder soil to a too-clean gravel source. The materials may be thoroughly mixed on the roadway with a grader or, preferably, a rotary mixer.