

# Specific Gravity Flask Gives Repeatable Results

Here's how to perform bulk specific gravity and absorption determinations for aggregate with Phunque Flask from Humboldt Mfg.

by Bryce Simons

**W**hether your HMA production requires a state-of-the-art lab facility or some basic tests in a clean, adequate lab, you can stay in control of the bottom line with slight modifications to aggregate testing. For instance, when a shipment of material comes in for either your crew's state Superpave mix or for a client's special-order performance-graded binder mix, you want to double-check the specific gravity of the aggregate just to be sure you've got what you need to make a spec-perfect product. Do you have personnel on hand who are accustomed to using a cone and tamper for this? Do they all check absorption the exact same way? Do the technicians get repeatable results among them?

Perhaps not.

The ability to repeat tests accurately, achieving near-exact results is essential for lab testing, whether you're in a state-of-the-art lab facility or not. To eliminate variables, such as user reproduction between technicians, the researchers and developers at Humboldt Manufacturing, Norridge, Ill., introduced the Phunque Flask and a method for using it to determine bulk specific gravity and absorption of aggregate. While this can be done at any stage of aggregate processing, it can certainly be a handy testing tool for personnel performing "quick" checks as material is delivered to the plant.

First, make sure personnel understand the terms used in the measurements discussed here. Bulk specific gravity, as defined by members of the American Association of State and Highway Transportation Officials (AASHTO), is the characteristic generally used for calculations of the volume occupied by the aggregate in various mixes containing aggregate that are proportioned or analyzed on an absolute volume basis. In other words, it's the measure of volume the aggregate takes up. Bulk specific gravity is also used in computations to determine the volume within the overall mix that is filled by aggregate. Bulk specific gravity can be determined



When performing bulk specific gravity tests, lab techs eliminate all released air during the soak period before taking final readings. The flask must be completely shaken and agitated, and then allowed to rest undisturbed so all of the air has escaped.

for dry aggregate (bulk dry) or for saturated aggregate (bulk SSD).

Although you may have no need for it, personnel can be familiar with the term "apparent specific gravity," which AASHTO members reported pertains to the relative density of the solid material making up the constituent particles (not including the pore space within the particles that is accessible to water).

Absorption values are used to calculate the change in the mass of an aggregate due to water absorbed in its pore spaces, compared to the dry condition, when the aggregate has been soaked with water long enough to satisfy most of its absorption potential. According to AASHTO, the lab standard for absorption is approximately 15 hours in water, but you'll see that the method below gives ample opportunity for absorption at about 25 total hours.

To prepare for the test method, calibrate the Phunque Flask by first determining its

empty weight (in grams). Next, fill the flask with distilled, 70-degree Fahrenheit (21.11-degree Celcius) water until the bottom of the meniscus is even with the 10 mark. Weigh the flask again and subtract the empty weight from this measurement. Remove the 10 milliliters to get the value back to 0 and you will have the base volume of water, in ml.

After you have dried 2 kilograms (4.4 pounds) of the aggregate from the sample you wish to verify to a constant mass temperature of 230 degrees F +9 (110 degrees C +5), and allowed the sample to cool in a chamber that prevents the sample from absorbing any water from the surrounding environment, you're ready to conduct the test with the Phunque Flask. The following steps assume you're testing normal weight aggregate. (For lightweight aggregate, reduce the amount of the sample to 600 g +10 g for fine aggregate or 1,000 g for coarse and intermediate aggregate.)

- Step 1.** Weigh out 1,200 g (2.65 lbs.) of oven-dry sand—or 2,000 g (4.41 lbs.) of coarse or intermediate aggregate.
- Step 2.** Select the appropriate flask for the aggregate—use the small-necked flask for fine and the large-necked flask for intermediate or coarse.
- Step 3.** Fill the flask approximately 1/2 full, by height, with distilled water.
- Step 4.** Measure out, but do not add yet, approximately 250 g (8.82 ounces) of distilled water.\*1
- Step 5.** Dry the neck of the flask with a dry, absorbent swab.\*2
- Step 6.** Pour the aggregate sample into the flask as quickly as possible, but without plugging the neck.
- Step 7.** Start the timer immediately when the first “stone” hits the water in the flask.
- Step 8.** After all of the sample has been poured into the flask, immediately pour in the holdback water measured out in Step 4 so that the final water level is sufficiently far up the calibrated neck to allow for accurate readings while the water level drops to its anticipated final level, being careful not to shake or agitate the flask and contents.
- Step 9.** Take the initial reading 30 seconds after the first particle has entered the water.
- Step 10.** Place the flask on a scale and obtain the total weight of the flask, aggregate and water.
- Step 11.** Aggressively shake, roll and agitate the flask for a period of three minutes so that all of the air is allowed to escape. (A plug must be placed into the neck of the coarse aggregate flask to prevent loss of water during the shaking and agitation to prevent water loss during this step.)
- Step 12.** Allow the flask to remain undisturbed for two minutes.
- Step 13.** Obtain and record the reading after five minutes has elapsed.
- Step 14.** Repeat steps 11 through 13 to obtain additional readings at 10 minutes, 30 minutes, 60 minutes, 2 hours, 4 hours and 25 hours (plus or minus 1 hour), making sure to agitate all of the air out of the sample, as described in Step 11, and allowing the flask to settle for at least two minutes before taking each reading.\*3
- Step 15.** Add the base reading obtained from calibrating the flask to each of the individual readings.
- Step 16.** Plot the readings on semi-log paper with the x-axis being “time” on the logarithmic scale.
- Step 17.** Calculate absorption, conventional absorption, saturated bulk specific gravity ( $BSG_{SSD}$ ) and dry bulk specific gravity ( $BSG_d$ ) with the equations detailed below. If necessary, apparent dry specific gravity ( $ASG_d$ ) can be calculated as well, but this is rarely used for construction aggregate applications.



### Calculating absorption

$$\text{Absorption, percent} = [(V_i - V_{\text{final}})/W_d] \times 100$$

Where:

$V_i$  = Initial Reading

(The calibrated water volume at 0 plus the initial reading), ml

$V_{\text{final}}$  = Final Reading

(The calibrated water volume at 0 plus the final reading) ml

$W_d$  = Original dry weight of sample, g

### Calculating saturated bulk specific gravity ( $BSG_{SSD}$ )

$$BSG_{SSD} = (W_d + W_{\text{abs}})/(V_i - V_w)$$

Where:

$W_{\text{abs}}$  = Water absorbed into the sample, ( $V_i - V_f$ ), ml

$W_f$  = Weight of the flask, g

$V_w$  = Volume of water [ $W_T - (W_d + W_f)$ ], ml

$W_T$  = Total weight of the flask, water and sample, g

### Calculating dry bulk specific gravity ( $BSG_d$ )

$$BSG_d = W_d/(V_i - V_w)$$

### Calculating conventional absorption

$$\text{Conventional absorption, percent} =$$

$$[(\text{Absorption} \times 1.8243) + 0.0038] \times 100$$

### Calculating apparent dry specific gravity ( $ASG_d$ )

$$W_d/[(W_d + W_f + V_f) - (W_T - R_{\text{final}})]$$

Where:

$V_f$  = calibrated volume of flask, ml

$R_{\text{final}}$  = Final direct reading, ml

\*1 The water in Steps 2 and 3 will probably need to be adjusted for the individual flask being used. It's important that during the filling process, the combined initial volume of water and the dry soil not plug the neck of the flask.

\*2 If the neck is not completely dry, then the finer portions of the sample get clogged up on the water droplets and tend to plug the neck of the flask as the sample is being poured in. Also, don't use an outside funnel because sand can plug the smaller hole of the funnel.

\*3 Remember to eliminate all released air during the soak period from the flask before taking the final reading. Make sure that the flask has been completely shaken and agitated, and then allowed to rest undisturbed so all of the air has escaped. Take as much time as required to completely eliminate all of the air.

## Quality Control Helps Everyone's Bottom Line

Keep in mind that aggregate testing at the time of delivery is not a sign of distrust. You're not questioning your supplier's ability to deliver a quality product, but you are double-checking your material supply. That's called quality control, and it's expected in an industry as spec-tight as ours. By performing a bulk specific gravity/absorption determination routine test, you're doing your job of safeguarding your material supply chain. And if you notice something out of spec, your material supplier will be relieved to hear of it now rather than 500,000 tons down the line. By catching a problem in his production or screening process, you could save both your supplier and you a heap of money in penalties or claims.



The Phunque flask can be used to double-check the specific gravity of incoming aggregate to ensure you've got what you need to make a spec-perfect mix.

When performed correctly, following the steps above, the test for bulk specific gravity and absorption level for aggregate can give accurate, repeatable results with the Phunque Flask. By charting the results, as directed in Step 15, technicians can track specific gravities and maintain a moving-average chart. This way, a producer would be able to calculate volumetrics using a moving average approach for the aggregate being used currently, rather than relying on values determined in the past. The producer also has a repeatable test that any member of his team can learn to perform with accurate, useful results. **AP**

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