

METHODS OF SAMPLING AND TESTING
MT 206-04
TERMS RELATING TO DENSITY AND SPECIFIC GRAVITY
OF SOLIDS, LIQUIDS, AND GASES
(Modified AASHTO 132)

1 Introduction:

1.1 Attention is called to the Appendix for information concerning the definitions that follow. Their meanings and their relationships to scientific terms are briefly explained. Some standards in which they are used are compared with standards in which other definitions have been applied.

1.2 Density (of solids and liquids)--The mass of a unit volume of a material at a specified temperature. The units shall be stated, such as grams per milliliter, grams per cubic centimeter, pounds per cubic foot, or other. If the material is a solid, the volume shall be that of the impermeable portion. The form of expression shall be:

Density at x

where x is the temperature of the material.

1.3 Density (of gases)--The mass of a unit volume of a gas at a stated temperature and pressure. The units shall be stated. The form of expression shall be:

Density at x, y

where:

x = temperature of the gas; and

y = pressure of the gas.

1.4 Density, Apparent (of solids and liquids)--The weight in air of a unit volume of a material at a specified temperature. The units shall be stated. If the material is a solid, the volume shall be that of the impermeable portion. The form of expression shall be:

Apparent density at x

where x is the temperature of the material.

1.5 Density, Bulk (of solids)--The weight in air of a unit volume of a permeable material (including both permeable and impermeable voids normal to the material) at a stated temperature. The unit shall be stated. The form of expression shall be:

Bulk density at x

where x is the temperature of the material

Note 1 - The accuracy of bulk density determinations is so low that corrections for air buoyancy and variations in the value for the acceleration of gravity are not warranted. Hence, this definition is based on weights in air.

1 Introduction: (continued)

- 1.6 Specific Gravity** (of solids and liquids)--The ratio of the mass of a unit volume of a material at a stated temperature to the mass of the same volume of gas-free distilled water at a stated temperature. If the material is a solid, the volume shall be that of the impermeable portion. The form of expression shall be:

Specific gravity $x/y^{\circ}\text{C}$

where:

x = temperature of the material, and

y = temperature of the water.

Note 2 - The term "relative density" with the same meaning as specific gravity is becoming more widely used.

- 1.7 Specific Gravity** (of gases) - the ratio of the density of a gas, under the observed conditions of temperature and pressure, to the density of dry air of normal carbon dioxide content, at the same temperature and pressure. The units shall be stated. The form of expression shall be:

Apparent specific gravity x/y

where:

x = temperature of the gas, and

y = pressure of the gas.

- 1.8 Specific Gravity, Apparent** (of solids and liquids)--the ratio of the weight in air of a unit volume of a material at a stated temperature to the weight in air of equal density of an equal volume of gas-free distilled water at a stated temperature. If the material is a solid, the volume shall be that of the impermeable portion. The form of expression shall be:

Apparent specific gravity $x/y^{\circ}\text{C}$

where:

x = temperature of the material, and

y = temperature of the water.

- 1.9 Specific gravity, Bulk** (of solids)--the ratio of the weight in air of a unit volume of a permeable material (including both permeable and impermeable voids normal to the material) at a stated temperature to the weight in air of equal density of an equal volume of gas-free distilled water at a stated temperature. The form of expression shall be:

Bulk specific gravity $x/y^{\circ}\text{C}$

where:

x = temperature of the material, and

y = temperature of the water.

2 Appendix: Discussion of Definitions and Relationship to Scientific Terms

- 2.1 In scientific terminology, mass is a measure of the quantity of material in a body, and is constant regardless of geographical location, altitude, or atmospheric conditions, so long as no material is added or taken away. Weight is the force with which a body is attracted to the earth and varies from place to place with the acceleration of gravity.
- 2.2 When an equal-arm balance is used to compare an object with standards of mass ("weights"), the effects of variations in the acceleration of gravity are self-eliminating and need not be taken into account, but the apparent mass of the object is slightly different from the true mass because of the buoyant effects of the surrounding air. Mass can then be computed from apparent mass by applying a correction for air buoyancy. When a spring balance is used, an additional correction accounting for the local value of the acceleration of gravity is required for the computation of mass.
- 2.3 For many commercial and industrial processes the rigorous scientific distinction between mass, apparent mass, and weight is of no practical consequence and is therefore ignored. The term "weight" in general practice has been accepted as being the value secured when an object is weighed in air. This "weight" or "weight in air" is often converted to "weight in vacuo" by the application of an air buoyancy correction, and is then considered as synonymous with mass.
- 2.4 All of the definitions listed above are based on either "mass" or "weight in air," the distinction being that air buoyancy corrections have been applied in the former case and not in the latter. Density and specific gravity are based on mass, and should be similarly constant. Apparent density, bulk density, apparent specific gravity, and bulk specific gravity are based on weight in air, and therefore are subject to change with atmospheric conditions, locality, and altitude. These changes may be negligible, depending upon the accuracy required for the particular application.
- 2.5 The definitions are intended as a guide for future standardization of terminology relating to density and specific gravity. They do not represent the terminology presently used in many existing AASHTO and ASTM standards, which has become diversified to an undesirable extent by the variety of materials, procedures, and trade practices involved.
- 2.6 Specific gravity definitions refer to the weight of a unit volume of the sample compared with the weight of a unit volume of water.
- 2.7 The definition of bulk density, like the previous definition of bulk specific gravity, specifies that the volume shall include both permeable and impermeable voids normal to the material. This requirement for the inclusion of all voids is completely satisfied whether the volume is computed from the measured dimensions of a solid, or whether it is found by placing the material in a container of predetermined capacity. It would be expected that all standards using either of the two methods would identify the results in like terms.
- 2.8 The terms "permeable" and "impermeable" cannot be rigidly defined for general application. The exact meaning in a particular application is the conventional one inferred by the procedure specified for determining the density or specific gravity of the material in question. In AASHTO T 84 and T 85, the spaces between grains or particles of granular aggregates are not included in the permeable voids mentioned in the definition for bulk specific gravity. On the other hand, in AASHTO T 166, the method of test is designed to include in the permeable voids the spaces between particles or substances in compacted bituminous paving mixtures or other bonded or cemented mixtures.