Designation: D6270 – 20

Standard Practice for Use of Scrap Tires in Civil Engineering Applications[1]

This standard is issued under the fixed designation D6270; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice provides guidance for testing the physical properties, design considerations, construction practices, and leachate generation potential of processed or whole scrap tires in lieu of conventional civil engineering materials, such as stone, gravel, soil, sand, lightweight aggregate, or other fill materials.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C127 Test Method for Relative Density (Specific Gravity) and Absorption of Coarse Aggregate

C136/C136M Test Method for Sieve Analysis of Fine and Coarse Aggregates

D698 Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))

D1557 Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3))

D1566 Terminology Relating to Rubber

D2434 Test Method for Permeability of Granular Soils (Constant Head)

D2974 Test Methods for Determining the Water (Moisture) Content, Ash Content, and Organic Material of Peat and Other Organic Soils

D3080/D3080M Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions (Withdrawn 2020)[3]

D4253 Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table

D5681 Terminology for Waste and Waste Management

D7760 Test Method for Measurement of Hydraulic Conductivity of Materials Derived from Scrap Tires Using a Rigid Wall Permeameter

F538 Terminology Relating to the Characteristics and Performance of Tires

2.2 *American Association of State Highway and Transportation Officials Standards:*

T 274 Standard Method of Test for Resilient Modulus of Subgrade Soils[4]

M 288 Standard Specification for Geotextiles[5]

2.3 *U.S. Environmental Protection Agency Standard:*

Method 1311 Toxicity Characteristics Leaching Procedure[6]

3. Terminology

3.1 *Definitions*—For definitions of common terms used in this practice, refer to Terminologies D5681 (waste management), F538 (tires), and D1566 (rubber), respectively.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *bead wire, n*—a high-tensile steel wire surrounded by rubber, which forms the bead of a tire that provides a firm contact to the rim.

3.2.2 *casing, n*—the tire structure not including the tread portion of the tire.

3.2.3 *mineral soil, n*—soil containing less than 5 % organic matter as determined by a loss on ignition test. **(D2974)**

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[1] This practice is under the jurisdiction of ASTM Committee D34 on Waste Management and is the direct responsibility of Subcommittee D34.03 on Treatment, Recovery and Reuse.

Current edition approved Sept. 1, 2020. Published September 2020. Originally approved in 1998. Last previous edition approved in 2017 as D6270 – 17. DOI: 10.1520/D6270-20.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

[4] *Standard Specifications for Transportation Materials and Methods of Sampling and Testing, Part II: Methods of Sampling and Testing*, American Association of State Highway and Transportation Officials, Washington, DC.

[5] *Standard Specifications for Transportation Materials and Methods of Sampling and Testing, Part I: Specifications*, American Association of State Highway and Transportation Officials, Washington, DC.

[6] *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, 3rd ed., Report No. EPA 530/SW-846, U.S. Environmental Protection Agency, Washington, DC.

3.2.4 *preliminary remediation goal, n*—risk-based concentrations that the USEPA considers to be protective for lifetime exposure to humans.

3.2.5 *rough shred, n*—a piece of a shredded tire that is larger than 50 by 50 by 50 mm, but smaller than 762 by 50 by 100 mm.

3.2.6 *rubber buffings, n*—vulcanized rubber usually obtained from a worn or used tire in the process of removing the old tread in preparation for retreading.

3.2.7 *rubber fines, n*—small particles of ground rubber that result as a by-product of producing shredded rubber.

3.2.8 *scrap tire, n*—a pneumatic rubber tire discarded because it no longer has value as a new tire, but can be either reused and processed for similar applications as new or processed for other applications not associated with its originally intended use.

3.2.9 *steel belt, n*—rubber-coated steel cords that run diagonally under the tread of steel radial tires and extend across the tire approximately the width of the tread.

3.2.10 *tire chips, n*—pieces of scrap tires that have a basic geometrical shape and are generally between 12 and 50 mm in size and have most of the wire removed.

3.2.11 *tire-derived aggregate (TDA), n*—pieces of scrap tires that have a basic geometrical shape and are generally between 12 and 305 mm in size and are intended for use in civil engineering applications.

3.2.12 *waste tire, n*—a tire that is no longer capable of being used for its original purpose, but has been disposed of in such a manner that it cannot be used for any other purpose.

3.2.13 *whole tire, n*—a tire that has been removed from a rim but has not been processed.

4. Significance and Use

4.1 This practice is intended for use of scrap tires including: tire-derived aggregate (TDA) comprised of pieces of scrap tires, TDA/soil mixtures, tire sidewalls, and whole scrap tires in civil engineering applications. This includes use of TDA and TDA/soil mixtures as lightweight embankment fill; lightweight retaining wall backfill; drainage layers for roads, landfills, and other applications; thermal insulation to limit frost penetration beneath roads; insulating backfill to limit heat loss from buildings; vibration damping layers for rail lines; and replacement for soil or rock in other fill applications. Use of whole scrap tires and tire sidewalls includes construction of retaining walls, drainage culverts, road-base reinforcement, and erosion protection, as well as use as fill when whole tires have been compressed into bales. It is the responsibility of the design engineer to determine the appropriateness of using scrap tires in a particular application and to select applicable tests and specifications to facilitate construction and environmental protection. This practice is intended to encourage wider utilization of scrap tires in civil engineering applications.

4.2 Three TDA fills with thicknesses in excess of 7 m have experienced a serious heating reaction. However, more than 100 fills with a thickness less than 3 m have been constructed with no evidence of a deleterious heating reaction (**1**).[7] Guidelines have been developed to minimize internal heating of TDA fills (**2**) as discussed in 6.11. The guidelines are applicable to fills less than 3 m thick. Thus, this practice should be applied only to TDA fills less than 3 m thick.

5. Material Characterization

5.1 The specific gravity and water absorption capacity of TDA should be determined in accordance with Test Method C127. However, the specific gravity of TDA is less than half the value obtained for common earthen coarse aggregate, so it is permissible to use a minimum weight of test sample that is half of the specified value. The particle density or density of solids of TDA (ρ_s) may be determined from the apparent specific gravity using the following equation:

$$\rho_s = S_a(\rho_w) \quad (1)$$

where:

S_a = apparent specific gravity, and
ρ_w = density of water.

5.2 The gradation of TDA should be determined in accordance with Test Method C136/C136M. However, the specific gravity of TDA is less than half the values obtained for common earthen materials, so it is permissible to use a minimum weight of test sample that is half of the specified value.

5.3 The laboratory-compacted dry density (or bulk density) of TDA and TDA/soil mixtures with less than 30 % retained on the 19.0-mm sieve can be determined in accordance with Test Methods D698 or D1557. However, TDA and TDA/soil mixtures used for civil engineering applications almost always have more than 30 % retained on the 19.0-mm sieve, so these methods generally are not applicable. A larger compaction mold should be used to accommodate the larger size of the TDA. The sizes of typical compaction molds are summarized in Table 1. The larger mold requires that the number of layers, or the number of blows of the rammer per layer, or both, be increased to produce the desired compactive energy per unit volume. Compactive energies ranging from 60 % of Test Methods D698 (60 % × 600 kN-m/m^3 = 360 kN-m/m^3) to 100 % of Test Methods D1557 (2700 kN-m/m^3) have been used. Compaction energy has only a small effect on the resulting dry density (**3**); thus, for most applications it is permissible to use a compactive energy equivalent to 60 % of Test Methods D698. To achieve this energy with a mold

[7] The boldface numbers in parentheses refer to the list of references at the end of this standard.

TABLE 1 Size of Compaction Molds Used to Determine Dry Density of TDA

Maximum Particle Size (mm)	Mold Diameter (mm)	Mold Volume (m^3)	Reference
75	254	0.0125	(**3**)
75	305	0.0146	(**4**)
51	203 and 305	N.R.[A]	(**5**)

[A] N.R. = not reported.

volume of 0.0125 m^3 would require that the sample be compacted in five layers with 44 blows per layer with a 44.5 N rammer falling 457 mm. The water content of the sample has only a small effect on the compacted dry density (**3**) so it is permissible to perform compaction tests on air or oven-dried samples.

5.3.1 The dry densities for TDA loosely dumped into a compaction mold and TDA compacted by vibratory methods (similar to Test Methods D4253) are about the same (**4-6**). Thus, vibratory compaction of TDA in the laboratory (see Test Methods D4253) should not be used.

5.3.2 When estimating an in-place density for use in design, the compression of a TDA layer under its own self-weight and under the weight of any overlying material must be considered. The dry density determined as discussed in 5.3 are uncompressed values. In addition, short-term time-dependent settlement of TDA should be accounted for when estimating the final in-place density (**7**).

5.3.3 Values of the secant constrained modulus, M_{sec}, which vary linearly with the compacted unit weight and applied vertical stress, can be estimated as (**8**):

$$M_{sec} = 1.8\sigma v + 115\gamma - 458 \text{ kPa} \tag{2}$$

where:

σv = vertical stress, and
γ = compacted unit weight, kN/m^3.

5.3.4 Time-dependent settlement for an average duration of four weeks, ΔH_t, can be calculated as (**9**):

$$\Delta H_t = HC_{\alpha\varepsilon}\log\frac{t_1}{t_2} \tag{3}$$

where:

$C_{\alpha\varepsilon}$ = modified secondary compression index ≈0.0065 for 100 % TDA,
H = thickness of the TDA layer,
t_1 = time when time-dependent compression begins (assumed to be one day), and
t_2 = time at which the magnitude of time-dependent compression is required.

For long-term settlement, refer to X1.11.

5.4 The compressibility of TDA and TDA/soil mixtures can be measured by placing TDA in a rigid cylinder with a diameter several times greater than the largest particle size and then measuring the vertical strain caused by an increasing vertical stress. If it is desired to calculate the coefficient of lateral earth pressure at rest K_0, the cylinder can be instrumented to measure the horizontal stress of the TDA acting on the wall of the cylinder.

5.4.1 The high compressibility of TDA necessitates the use of a relatively thick sample. In general, the ratio of the initial specimen thickness to sample diameter should be greater than one. This leads to concerns that a significant portion of the applied vertical stress could be transferred to the walls of the cylinder by friction. If the stress transferred to the walls of the cylinder is not accounted for, the compressibility of the TDA will be underestimated. For all compressibility tests, the inside of the container should be lubricated to reduce the portion of the applied load that is transmitted by side friction from the sample to the walls of the cylinder. For testing where a high level of accuracy is desired, the vertical stress at the top and the bottom of the sample should be measured so that the average

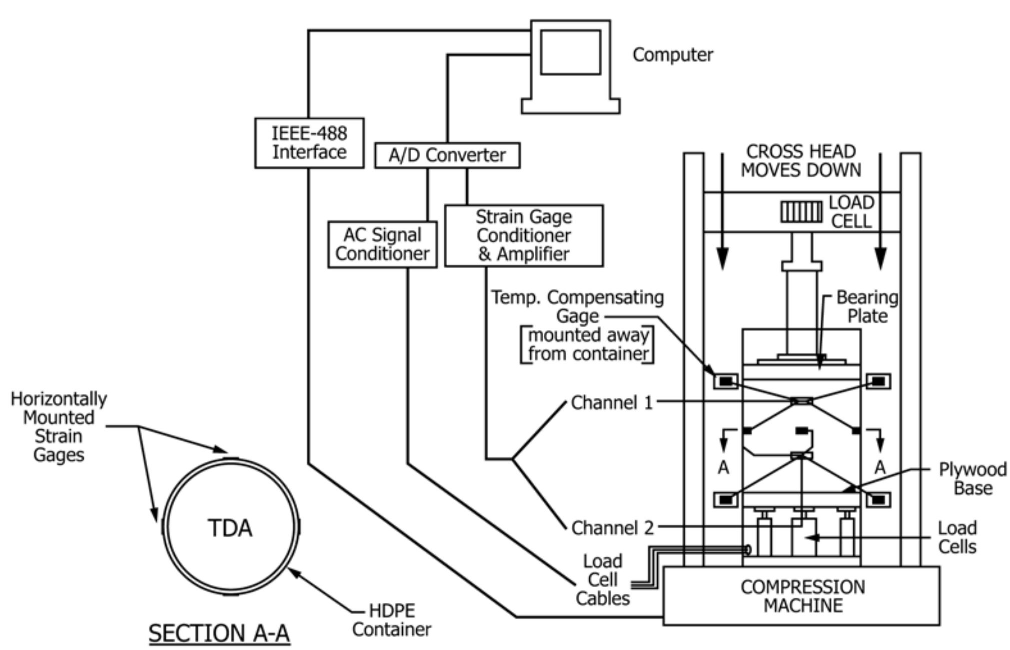

FIG. 1 Compressibility Apparatus for TDA Designed to Measure Lateral Stress and the Portion of the Vertical Load Transferred by Friction from TDA to Container (11)