



Standard Test Method for Determination of Sediment Retention Device Effectiveness in Sheet Flow Applications¹

This standard is issued under the fixed designation D7351; 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 test method establishes the guidelines, requirements and procedures for evaluating the ability of Sediment Retention Devices (SRDs) to retain sediment when exposed to sediment-laden water “sheet” flows.

1.2 This test method is applicable to the use of an SRD as a vertical permeable interceptor designed to remove suspended soil from overland, nonconcentrated water flow. The function of an SRD is to trap and allow settlement of soil particles from sediment laden water. The purpose is to reduce the transport of eroded soil from a disturbed site by water runoff.

1.3 The test method presented herein is intended to indicate representative performance and is not necessarily adequate for all purposes in view of the wide variety of possible sediments and performance objectives.

1.4 The values stated in SI units are to be regarded as standard. The inch-pound values given in parentheses are provided for information purposes only.

1.5 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice [D6026](#).

1.5.1 The procedures used to specify how data are collected/recorded and calculated in this standard are regarded as the industry standard. In addition, they are representative of the significant digits that should generally be retained. The procedures used do not consider material variation, purpose for obtaining the data, special purpose studies, or any consideration for the user’s objectives; and it is common practice to increase or reduce significant digits of reported data to commensurate with these considerations. It is beyond the scope of this standard to consider significant digits used in analysis methods for engineering design.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the*

responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

2.1 *ASTM Standards:*²

[D653 Terminology Relating to Soil, Rock, and Contained Fluids](#)

[D698 Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort \(12 400 ft-lbf/ft³ \(600 kN-m/m³\)\)](#)

[D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction](#)

[D5141 Test Method for Determining Filtering Efficiency and Flow Rate of the Filtration Component of a Sediment Retention Device](#)

[D6026 Practice for Using Significant Digits in Geotechnical Data](#)

3. Terminology

3.1 For definitions of terms used in this test method, see Terminology [D653](#).

4. Summary of Test Method

4.1 Sediment-laden water is allowed to “sheet flow” up to and seep through, over, or under, or a combination thereof, an installed sediment retention device (SRD). At a minimum, the amount (via water and soil weight) of sediment-laden flow is measured both upstream and downstream of the SRD.

4.2 The measurement of sediment that passes through, over, or under, or a combination thereof, the SRD compared to the

¹ This test method is under the jurisdiction of ASTM Committee [D18](#) on Soil and Rock and is the direct responsibility of Subcommittee [D18.25](#) on Erosion and Sediment Control Technology.

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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.

amount in the upstream flow is used to quantify the effectiveness of the SRD in retaining sediments.^{3, 4}

5. Significance and Use

5.1 This test method quantifies the ability of a sediment retention device (SRD) to retain eroded sediments caused by sheet flowing water under full-scale conditions. This test method may also assist in identifying physical attributes of SRDs that contribute to their erosion control performance.

5.2 The effectiveness of SRDs is installation dependent. Thus, replicating field installation techniques is an important aspect of this test method. This test method is full-scale and therefore, appropriate as an indication of product performance, for general comparison of product capabilities, and for assessment of product installation techniques.

NOTE 1—Test Method D5141 is an alternate test method for evaluating sediment retention device effectiveness, if it is not necessary to simulate field installation conditions.

NOTE 2—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with Practice D3740 does not in itself assure reliable results. Reliable results depend on many factors: Practice D3740 provides a means of evaluating some of those factors.

³ Sprague, C.J., "Testing the Effectiveness of Sediment Retention Devices," *StormCon '04*, Palm Desert, CA, (digital proceedings), 2004.

⁴ Sprague, C.J., and Carpenter, T., "A New Procedure for Testing the Effectiveness of Sediment Retention Devices," *Conference XXXV*, International Erosion Control Assoc., Philadelphia, 2004, pp. 265–275.

6. Apparatus

6.1 *Equipment required (see Fig. 1 and Fig. 2):*

6.1.1 *Combination Mixing Tank and Scale*—A tank with an internal paddle mixer device mounted on scales capable of holding/weighing 4500 kg of sediment-laden water.

6.1.2 *A Clean Water Source and Pumping Equipment*—A source of water and associated pumping equipment sufficient to repeatedly fill the mixing tank in a timely manner.

6.1.3 *A Consistent Soil Stockpile*—A stockpile of soil in sufficient quantity to both create sediment-laden water and to create/replace subgrade in the installation zone. The general soil type to be used for testing shall be loam with target grain sizes and plasticity index as shown in Table 1, unless otherwise specified.

6.1.4 *A Loader for Moving the Soil to the Mixer*—A front-end loader of sufficient reach and capacity to dump a prescribed amount of soil into the mixing tank.

6.1.5 *A Variable Discharge Apparatus from the Mixer*—A variable discharge apparatus from the mixer — A valve-controlled discharge hose that allows for controlled, uniform discharge from the mixing tank.

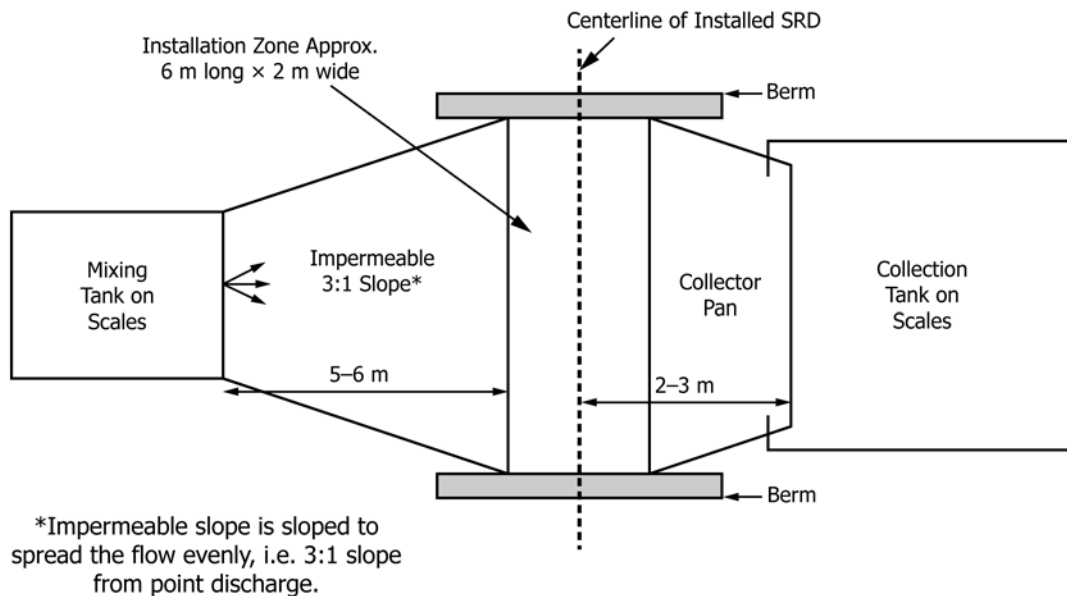
6.1.6 *Soil and Water Sampling Equipment*—Sampling jars (at least 12 per test) for taking "grab" samples periodically during the test.

6.1.7 *Excavating/Compacting Machinery for Cleaning and Preparing the Test Area*—Earthmoving and compacting equipment is needed to prepare/replace the soil in the installation zone.

6.1.8 *A Scaled Collection System Adequate to Handle the Released Runoff*—A tank mounted on scales of sufficient volume to collect all runoff passing the SRD.

6.2 Retention Area:

6.2.1 A non-permeable, smooth, 3:1 slope surface (at least 5 m long) immediately below the mixer discharge shall be provided to spread the discharge to the width of the retention



*Impermeable slope is sloped to spread the flow evenly, i.e. 3:1 slope from point discharge.

FIG. 1 Profile Schematic

Diagram of Proposed Testing Equipment
(not to scale)

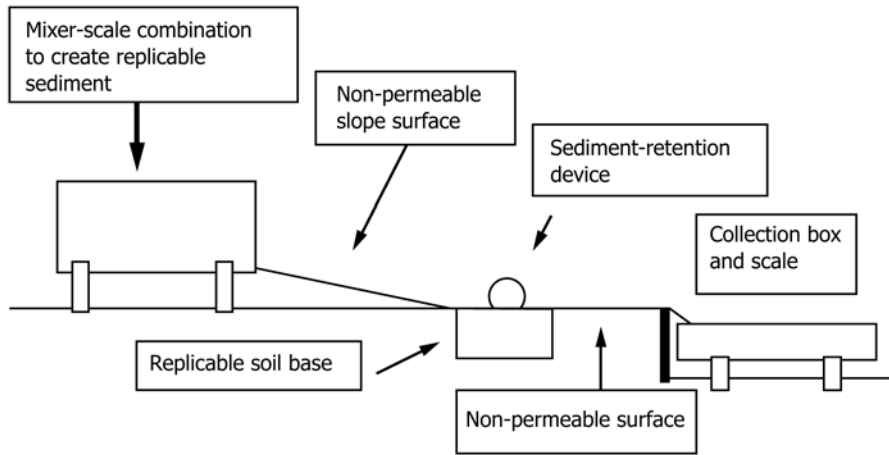


FIG. 2 Schematic (Plan) Diagram

TABLE 1 Target Grain Sizes and Plasticity Indices

Particle Size	Sand	Loam	Clay
D ₁₀₀ (mm)	25 > D ₁₀₀ > 3.0	10 > D ₁₀₀ > 0.3	3.0 > D ₁₀₀ > 0.02
D ₈₅ (mm)	4.0 > D ₈₅ > 0.8	0.8 > D ₈₅ > 0.08	0.008 > D ₈₅ > 0.003
D ₅₀ (mm)	0.9 > D ₅₀ > 0.2	0.15 > D ₅₀ > 0.015	0.015 > D ₅₀ > 0.0008
D ₁₅ (mm)	0.3 > D ₁₅ > 0.01	0.03 > D ₁₅ > 0.001	D ₁₅ > 0.002
Plasticity Index	N/A (nonplastic)	2 < PI < 8	10 < PI

zone (length of the SRD installation) and to provide a retention zone above the installation zone.

6.2.2 An installation zone approximately 2 m wide by the intended length of the SRD installation (typically 20 ft) comprised of prepared soil subgrade to allow full-scale installation of the SRD to be tested.

6.2.3 The center of the installed SRD should be placed in the center of the installation zone each time to replicate height of water as it relates to volume retained.

6.2.4 The prepared soil subgrade will be compromised each test, so it will have to be reconstructed after each test.

6.2.5 The area below the installation zone should be non-permeable to facilitate efficient transmission of runoff passing the SRD to the collection tank.

6.3 The Collection Area:

6.3.1 The collection tank shall be at a lower grade than the installation area so that runoff passing the SRD will efficiently flow via gravity into the tank. A retaining wall between the installation zone and the collection tank is recommended. The area between the retaining wall and the installed SRD should be impermeable, and so facilitate collection of sediments deposited after passing the SRD but before entering the collection tank.

7. SRD Installation

7.1 A representative sample of the SRD to be tested shall be used.

7.2 The SRD sample shall be installed in accordance with the manufacturer’s recommendations or, lacking recommendations, in accordance with generally accepted construction procedures, including orientation perpendicular to flow with appropriate trenching and/or staking.

struction procedures, including orientation perpendicular to flow with appropriate trenching and/or staking.

8. Procedure

8.1 SRD Installation:

8.1.1 Prepare the installation zone using the same soil to be used as sediment, unless otherwise agreed with the client. The soil shall be placed to a depth in excess of the depth of installation and compacted to $90 \pm 3\%$ of Standard Proctor density, at a soil moisture within $\pm 3\%$ of optimum moisture content in accordance with Test Method D698, unless otherwise requested by the client. The installation zone should be wide enough to accommodate the desired length of SRD. Unless otherwise agreed with the client, the SRD length exposed to flow between end abutments shall be sufficient to completely contain the test flow, but no more than the 7 m.

8.2 Mixing, Releasing, and Collecting Sediment-Laden Runoff:

8.2.1 Procure soil as described in 6.1.3 in adequate quantities for the testing process, determine its characteristics for future replication needs, and cover to prevent contamination and rainfall degradation.

8.2.2 Create sediment-laden runoff by combining water and soil in the mixing tank and maintain agitation during the test. Unless otherwise directed by the client, 2270 kg of water and 136 kg of soil shall be combined to create the sediment-laden runoff. This amount of water and sediment simulates sheet flow from a slope measuring 6.1 m wide by 30 m long exposed to the peak 30 min of a 100 mm per hour rainfall hydrograph.

NOTE 3—An important variable in any testing procedure is the

establishment of test “conditions.” For a sediment control performance test this means selecting an appropriate design storm event and associated runoff along with an expected amount of sediment to be transported by the runoff. For this testing, a standard 10-y, 6-h storm event (mid-Atlantic region of US) was selected. This return frequency is commonly used for sizing sediment control ponds and, thus, was deemed appropriate for the testing of other SRDs. Using this criterion, a 100 mm (4 in.) rainfall was selected. It was also assumed that approximately 25 % of the storm would occur during the peak 30 minutes, and that 50 % of the rainfall would infiltrate into the ground (Goldman, et al., 1986).⁵ A theoretical contributory area of 30 m (100 ft) slope length by 6 m (20 ft) wide was selected to limit runoff to sheet flow conditions (Richardson, 1990).⁶ Runoff and associated sediment were calculated using the Modified Universal Soil Loss Equation (MUSLE) which allows for calculating a storm-specific quantity of sediment. Following is the MUSLE (SI formula):

$$T = 89.6 (V \times Q_p)^{0.56} K L S C P$$

where:

T = sediment yield (tonnes),
 V = runoff (m^3) = (Rainfall – Infiltration) \times Area,
 Q = peak flow (m^3/s), and
 K, L, S, C, P = P are from RUSLE charts.

The following calculations provided the runoff and sediment load used in the testing:

$$V = (0.5)^* \times (0.1 \text{ m}) \times (180 \text{ m}^2) = 9 \text{ m}^3$$

where:

Q_p = $(0.1 \text{ m}) \times (0.25)^* \times (0.5)^{**} \times (180 \text{ m}^2) = 2.25 \text{ m}^3 / 30 \text{ min} = 0.00125 \text{ m}^3/s$ (* = 25 % of storm during 30-min peak; ** = 50 % infiltration)
 $K, \text{ sandy-silt}$ = 0.041; $L, S, 2-10 \text{ \%}/30 \text{ m} = 0.46$ (approximately); $C, P = 1.0$
 $T = 89.6 (9 \times 0.00125)^{0.56} (0.041) (0.46) (1.0) (1.0) = 0.136 \text{ Tonnes} = 136 \text{ kg}$ of soil (assume most sediment is generated during the peak flow period)

Test Quantities: 30-Minute Runoff: $2.25 \text{ m}^3 \times 1000 \text{ kg/m}^3 = 2250 \text{ kg}$ (approximately 5000 lb) Sediment Load: 136 kg (approximately 300 lb)^{5,6}

8.2.3 Discharge volume evenly for 30 min. Measure the quantity of released runoff at no less than 5-min intervals by noting the reduction in weight in the mixing tank. Adjust the valve on the outlet hose to increase/decrease flow to stay as close as possible to the target ($2700 \text{ kg} / 30 \text{ min} = 90 \text{ kg} / \text{min}$). Maintaining a relatively steady and accurate flow rate is important, as the calculations will assume that this flow rate is constant. The retention area construction and mixing tank discharge should combine to cause the flow to spread out to impact the full length of the SRD

NOTE 4—Larger flow rates than defined in 8.2.2 may not result in sheet flow impacting the SRD. If this occurs this test method is not appropriate

8.2.4 As runoff passing the SRD enters the collection tank, record the weight of the collection tank, and take grab samples of runoff entering the tank, at 5 min intervals.

8.2.5 Cutoff time is 90 min, unless otherwise directed by the client. An earlier cutoff time is acceptable when there is low-volume ponding and minimal discharge.

8.3 Data Collection:

8.3.1 *Grab Samples*—Collect grab samples at 5 min intervals at the mouth of the discharge from the mixing tank and

from a suitable downstream (between the installed SRD and the collection tank) location. Collect all samples in the same size container (250 ml bottles are recommended) and in the same manner. Pre-mark each container and do not overfill or overrun the sample bottle. Concentrations may be small, thus poor sampling techniques may significantly affect results. Multiple measurements cause a hectic pace, so pre-marking and immediately recording insures consistency and accuracy.

8.3.2 *Tank Measurements*—Sediment-laden water in both the mixing and collection tanks is primarily measured by weight.

8.3.3 *Observations*—Make and record visual observations relevant to the testing, such as height of the SRD, the depth of ponding (maximum depth and depth at end of test), undermining, overtopping, catastrophic product/system failure, etc. and the associated times. It is important to document the progression of undermining flows and associated times. Photographic and video documentation is preferred.

8.3.4 *Time Records*—Record the time of each grab sample, each tank and ponding depth measurement, and the time to reach zero ponding height, if reached within the time of the entire test.

8.3.5 *Sediments*—Collect and dry all sediments passing the SRD.

8.4 Lab Testing:

8.4.1 *Turbidity*—Grab samples shall be evaluated in a lab to determine turbidity.

8.4.2 *Percent Solids*—Grab samples shall be evaluated in a lab to determine percent dry solids content. Filtration is the recommended technique.

9. Calculation

9.1 Record all collected data in a table, noting the time of each sampling.

9.2 The total soil retained by the SRD during the test is calculated by first multiplying the percent solids for each grab sample by the time interval associated with that grab sample to obtain an interval average percent solids. Then multiply the interval average percent solids by the ratio of the associated time interval to the total time to obtain a weighted average percent solids. Sum all the weighted average percent solids to determine the total solids fraction. Calculations should be tabulated as shown in Fig. 3.

For each grab sample, calculate

Solids Fraction = (weight of sediment / weight of sediment/water mixture)

Weighted Average Solids Fraction = Solids Fraction \times (time interval / total test time)

Then, for all the grab samples, calculate

Total Solids Fraction = (Weighted Average Solids Fraction)

For the entire test, Total Collected Flow_{downstream} is the total mass (kg) of water and sediment collected in the Receiving Tank, plus the combined sediment/water mixture mass (kg) of the grab samples. Using that value,

Soil Retention, % = $100\% * \{1.0 - [(Total Collected Flowdownstream * Total Solids Fraction) / 136 \text{ kg}]\}$

⁵ Goldman, S.J., Jackson, K., and Bursztynsky, T.A., *Erosion and Sediment Control Handbook*, McGraw-Hill, 1986, p. 8.17.

⁶ Richardson, G.N., and Middlebrooks, P., “A Simplified Design Method for Silt Fences,” *Proceedings of Geosynthetics '91*, Atlanta, GA, IFAI, 1991, pp. 879–888.

Structure: _____ Test # _____
 Date: ____/____/____ Time: _____
 Batch: _____ of _____

Soil Base: Dry _____ Other _____ Base: Smooth or Roughened Height 1/2 1 1 1/2 2 2 1/2
 3
 Sediment Load Soil Type: _____
 Structure Details: _____

Silt Fence
 Sliced: _____ Trenched: _____
 Compacted: Yes or No _____ How: _____ Penetrometer: _____
 Post Spacing: 4' 5' 6' 8' 10'
 Post Location: Center of Test Offset from Center/Center of Trench Back of Trench
 Fabric Type: Flat/Flat Flat/Round Round/Round Prefab Wire – Reinforced
 Installed Height: 10 12 14 16 18 20 24 24+
 Trench Depth: 4 6 8 12
 Bladed Trench Depth: 6 8 10 Hand Cleaned: Yes No
 Backfill: Available or Supplemental Height of Backfill: Below Even 2" Over

Log Type: Wattle Filter log Compost Triangular Other: _____
 Trenched: 0 2" 4" 6"
 Structured Height: _____ Installed Height: _____
 Stakes O.C.: 0 2' 4' 6' 8' Depth in Soil _____
 Stake Location: Center Offset

Water Weight Start: _____ Comments: _____
 Soil 1 Weight: _____

Total Weight of Batch at Start: _____
 Discharge Time: Start: _____ End: _____ Net time: _____

Time Intervals		Mixer	Collection	Height Behind Structure
Start Scale				
	Sample 5		upstream	
10 Minute Scale				
	Sample 15		upstream	
20 Minute Scale				
	Sample 25		upstream	
30 Minute Scale		XXX		
	Sample 30	XXX		
45 Minute Scale		XXX		
	60 Minute	XXX		
75 Minute Scale		XXX		
	90 Minute	XXX		
120 Minute Scale		XXX		

Final: _____
 Comment on Samples: _____

Time to Install: _____
 Type of Future Test Needed: _____

FIG. 3 Example of Data Collection Sheet

9.3 The total percent water retention is found by similarly comparing the applied clean water to the clean water in the Receiving Tank. Calculations should be tabulated such as shown in Fig. 4.

$$\text{Water Retention, \%} = 100\% * \{1.0 - [(Total Collected Flow_{downstream} / 2700 \text{ kg}) * (1.0 - Total Solids Fraction)]\}$$

10. Report

10.1 The report shall at a minimum include the following:

10.1.1 General information, including test facility location, date, time, air and water temperature, and dimensions of test apparatus, along with any variations from the procedures detailed in 8.

10.1.2 Calibration data for tanks.

10.1.3 Test set-up activities, including (1) test conditions (that is, weight of water and soil used), (2) soil type and conditions, (3) SRD product type and description, and (4) SRD installation details.

10.1.4 Soil information shall be reported. The information shall include: soil type/texture (for example, topsoil, sandy loam, silt loam, clay), gradation (including hydrometer test for the P200 fraction), organic matter content, plasticity indices, and pH.

10.1.5 Raw data, including masses, percent solids, and associated times shall be reported.

10.1.6 All observations made in accordance with 8.3.3.

10.1.7 The calculated retention effectiveness for both soil and water for the SRD shall be reported.

Sample				Total Weight, g	Weight of Jar, g	Weight of sediment/water mixture	Weight of Seds	% Solids	Time Interval, min	Wtd. Avg Solids, %	Soil Retention, %	Time, mins.	Coll. Flow, kg	Water Retention, %	Test Set-up		
Date	Location	Test #	Spec #														
	Upstream																
				End Flow			Avg =	%	Sum:	%							
	Down-stream																
				End Flow			Avg =	%	Sum:	%							

FIG. 4 Example of Data Table for Testing

11. Precision and Bias

11.1 *Precision*—Test data on precision is not presented due to the nature of the soil materials tested by this method. It is either not feasible or too costly at this time to have ten or more laboratories participate in a round-robin testing program.

11.2 *Bias*—There is no accepted reference value for this test method, therefore, bias cannot be determined.

11.3 *Reproducibility*—The reproducibility of the test method is being determined.

12. Keywords

12.1 sediment; sediment control; sediment retention device; silt fence

ANNEX

(Mandatory Information)

A1. ANNEX

A1.1 Calibration of Collection Tank

A1.1.1 Weight measurements will be used to quantify the amount of sediment-laden flow both upstream and downstream of the installed SRD. While the amount of water/soil in the mixing tank is known and requires only the weight to be monitored, the downstream collection tank collects the volume of sediment-laden runoff passing the SRD and has an unknown solids content. As an extra measuring tool, a careful calibration of the collection tank that establishes the water depth versus

associated height (using clean water) can be used to determine (estimate) the amount of collected runoff that is soil (by weight) by documenting the collected runoff (weight and height) during the test and subtracting out the weight of the same height of pure water. The tank can be calibrated before testing by filling with clean water and making depth (volume) marks on the side of the tank based on the unit weight of clean water as the tank is filled.

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