

Porosity of Structural Backfill

Tech Sheet # 1

Rev. 1/16/06

General:

LandSaver advises that a porosity of 40% is appropriate to use for the storage capacity of structural aggregate used in the bedding and embedment zones around LandSaver chambers. This memo provides technical support for the use of a porosity of 40%. The major points of the memo are:

- 40% porosity is appropriate for the washed, open graded, angular aggregate material LandSaver recommends for foundation and embedment.
- Most of the porosity data available is based on a compacted condition. LandSaver requires compaction of the foundation (bedding) and allows dumped aggregate embedment around the chambers.
- Test data indicates that the average porosity of all gradations of the *compacted* foundation is approximately 40%. The porosity of the *dumped* backfill in the embedment zone is typically greater than 40% and the calculated weighted average porosity therefore exceeds 40% for typical LandSaver systems.
- Porosity is protected from soils migration by a non-woven geotextile that surrounds the entire system. For some exfiltration systems, a drainage net is substituted for the fabric on the bottom of the bed.

Terms:

Porosity (n) is defined as the volume voids over the total volume expressed as a percent: $n = (V_v / V_t) \times 100\%$. Other terms commonly used to describe porosity include; “voids” and “void space”. A related term that should not be confused with porosity is *void ratio* (e) which is the volume of voids over the volume of solids expressed as a decimal: $e = V_v / V_s$.

Compilation of Known Test Data:

| <u>Sample</u> | <u>Data Source</u> | <u>Porosity</u> | <u>Bulk Density</u> | <u>Test / Description</u> |
|---------------|---------------------|-----------------|---------------------------|--|
| AASHTO # 4 | StormTech lab | 39.9% | 94.3 lbs/ft ³ | dumped, corrected ¹ |
| AASHTO # 57 | StormTech lab | 45.4% | 87.2 lbs/ft ³ | dumped, corrected ¹ |
| AASHTO # 4 | StormTech lab | 37.4% | 103.0 lbs/ft ³ | jiggled - tamped, corrected ¹ |
| AASHTO # 57 | StormTech lab | 38.7% | 97.7 lbs/ft ³ | jiggled - tamped, corrected ¹ |
| AASHTO # 57 | NTH lab | 50 - 51% | | tapped & agitated, dried ² |
| AASHTO # 57 | NTH lab | 50 - 52% | | tapped & agitated, dried ² |
| AASHTO # 3 | NTH lab | 53 - 54% | | tapped & agitated, dried ² |
| -1 1/2" | Anderson Eng. Cons. | 41.9% | 96.8 lbs/ft ³ | jiggled - tamped, C29 ³ |
| -1 1/2" | Anderson Eng. Cons. | 35.3% | 101.7 lbs/ft ³ | jiggled - tamped, C29 ³ |
| -1 1/2" | Anderson Eng. Cons. | 37.8% | 98.6 lbs/ft ³ | jiggled - tamped, C29 ³ |
| -1 1/2" | Anderson Eng. Cons. | 41.3% | 93.6 lbs/ft ³ | jiggled - tamped, C29 ³ |
| -1 1/2" | Anderson Eng. Cons. | 38.2% | 98.7 lbs/ft ³ | jiggled - tamped, C29 ³ |
| -3/4" | Anderson Eng. Cons. | 38.5% | 100.3 lbs/ft ³ | jiggled - tamped, C29 ³ |
| -3/4" | Anderson Eng. Cons. | 38.9% | 97.9 lbs/ft ³ | jiggled - tamped, C29 ³ |

Compilation of Known Test Data (continued):

| <u>Sample</u> | <u>Data Source</u> | <u>Porosity</u> | <u>Bulk Density</u> | <u>Test / Description</u> |
|---------------|----------------------|-----------------|--------------------------|-----------------------------------|
| AASHTO # 4 | Universal Eng. Serv. | 44.3% | 78.6 lbs/ft ³ | roddeD - tamped, C29 ⁴ |
| AASHTO # 57 | Universal Eng. Serv. | 43.2% | 79.8 lbs/ft ³ | roddeD - tamped, C29 ⁴ |
| AASHTO # 4 | Universal Eng. Serv. | 46.1% | 70.8 lbs/ft ³ | roddeD - tamped, C29 ⁵ |
| AASHTO # 57 | Universal Eng. Serv. | 42.8% | 74.8 lbs/ft ³ | roddeD - tamped, C29 ⁵ |

- 1 Testing was conducted by StormTech in Oct of 2003 using aggregate from Connecticut. Water was used to fill voids and a correction factor that reduced porosities by 3 to 16% was calculated and applied to correct for wall effects of the test container.
- 2 Testing was conducted by NTH Consultants, Exton, PA in Dec 2002 for ADS. This was dry testing in accordance with the "Civil Engineering Reference Manual, Sixth Edition" by Michael R. Lindburg, PE.
- 3 Testing was conducted by Anderson Engineering Consultants, Inc., Little Rock, AR in February, 2000 for 7 different aggregate samples from four suppliers in Arkansas.
- 4 The material tested was lime rock from central Florida. Testing was conducted by Universal Engineering Sciences in Orlando, FL in November, 2005.
- 5 The material tested was recycled, crushed concrete from central Florida. Testing was conducted by Universal Engineering Sciences in Orlando, FL in November, 2005.

ASTM C29 is the "Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate".

Porosity References:

- "Urban Runoff Quality Management" WEF MOP 23 / ASCE MOP 87. Table 5.12 lists uniform sized gravel at 40%.
- "Controlling Urban Runoff:" by Thomas R. Schueler, July 1987 describes storage volume of the void space in the trench at 40% of the excavated trench volume.
- "On-site Stormwater Management: Applications for Landscape and Engineering" Second Edition by Bruce Ferguson and Thomas Debo states that open graded crushed stone has 40% void space.

