Sand: new insights into physical & chemical properties

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Asian Turfgrass Center
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USGA

USGA RECOMMENDATIONS FOR A METHOD OF

Putting Green Construction

2018 REVISION

FOR NEARLY 60 YEARS the USGA recommendations for putting green construction have been the most widely used method of putting green construction throughout the United States and other parts of the world. When built and maintained properly, putting greens built in accordance to the USGA recommendations have provided consistently good results for golf courses over a period of many years. These recommendations are periodically reviewed and updated as a result of scientific research and as new techniques and materials are proven reliable.

This document specifically represents the USGA's recommendations for putting green construction. It does not include a discussion of construction techniques or methods. Additional documents are available from the USGA that describe construction methods, offering tips for success and providing guidance for putting green management.

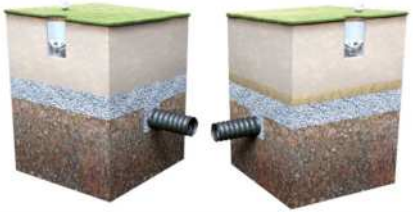


TABLE 3. Recommended Particle Size Distribution for a Putting Green Rootzone Mixture

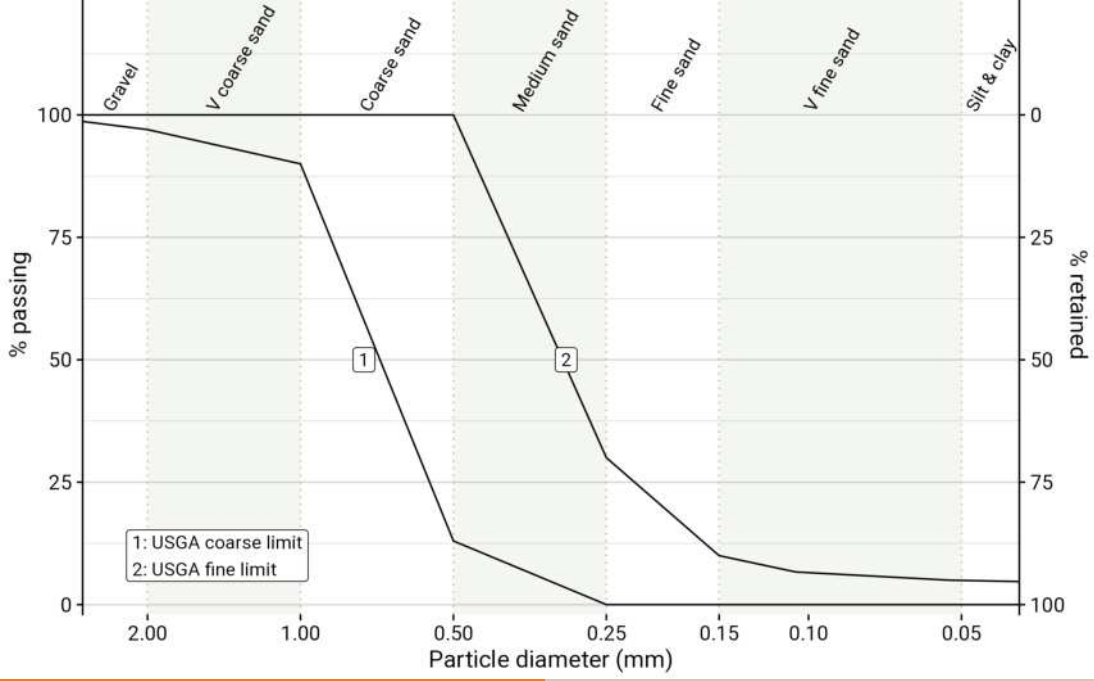
PARTICLE	DIAMETER	SIEVE	% BY WEIGHT
Coarse gravel	> 4 mm	No. 5	0%
Fine gravel	2.0 – 3.4 mm	No. 10	≤ 3% gravel
Very coarse sand	1 – 2 mm	No. 18	≤ 10% combined in this range
Coarse sand	0.5 – 1.0 mm	No. 35	≥ 60% of the particles in this range
Medium sand	0.25 – 0.5 mm	No. 60	
Fine sand	0.15 – 0.25 mm	No. 100	≤ 20%
Very fine sand	0.05 – 0.15 mm	No. 270	≤ 5%
Silt	0.002 – 0.05 mm		≤ 5%
Clay	< 0.002 mm		≤ 3%
Total fines	Very fine sand + silt + clay		≤ 10% combined
Coefficient of Uniformity (D60/D10)		1.8 - 3.5	Rootzone mixtures with peat
		2.0 - 3.5	Rootzone mixtures with inorganic amendments
		2.0 - 3.5	Pure sand rootzone mixtures

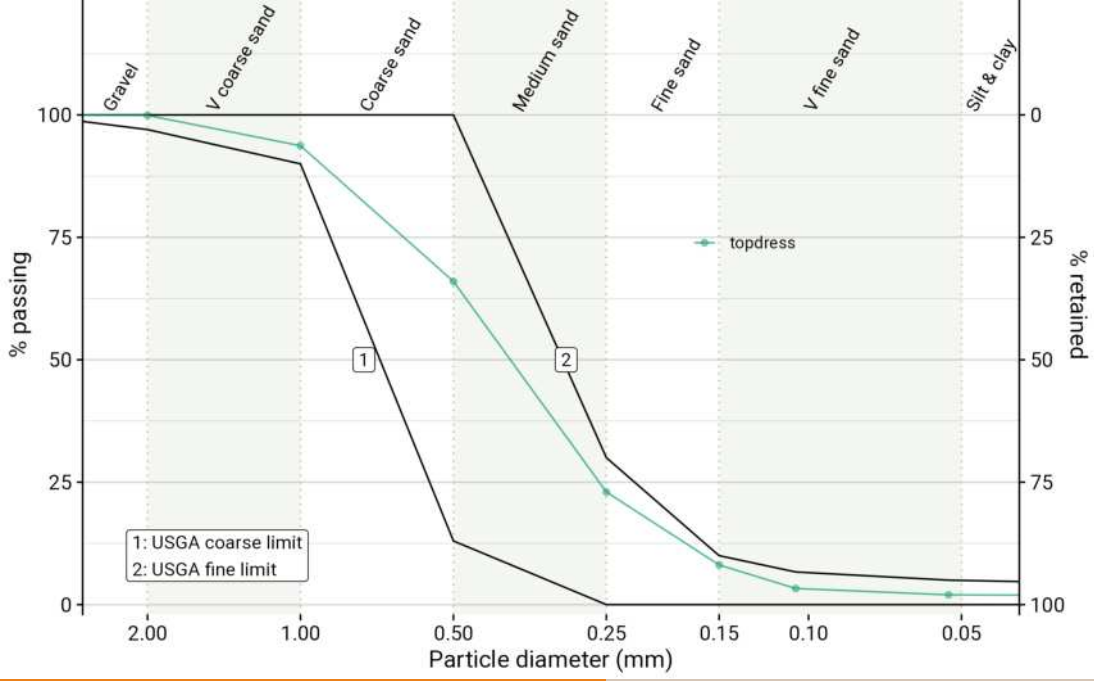

SH1
SH2

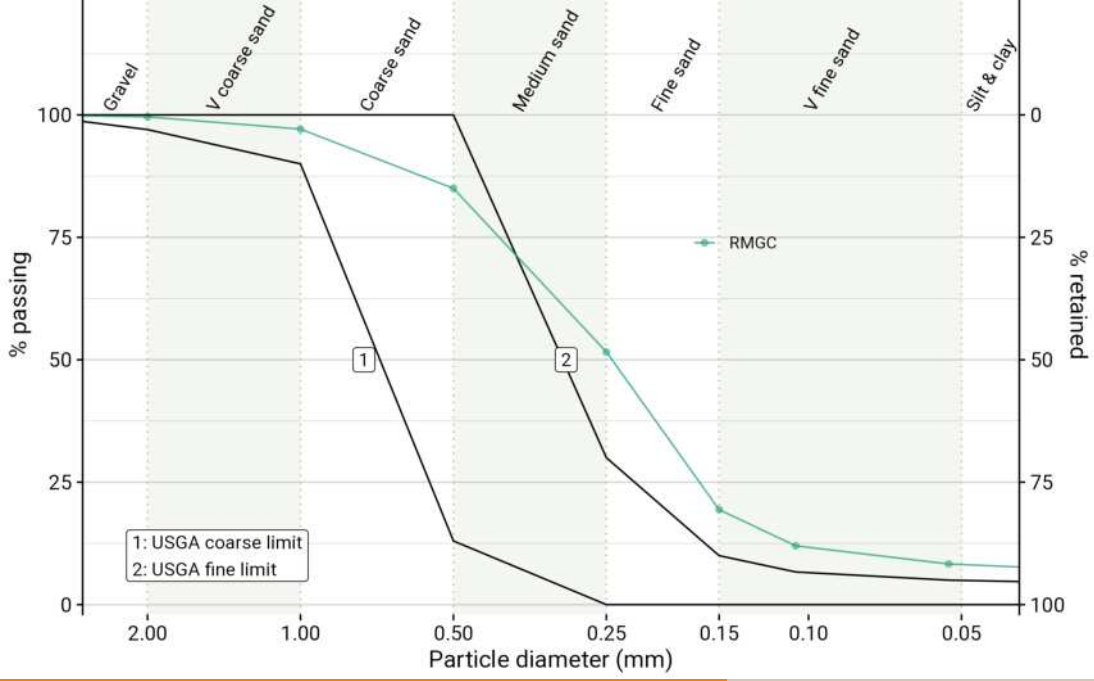
Sand fractions by depth after burning

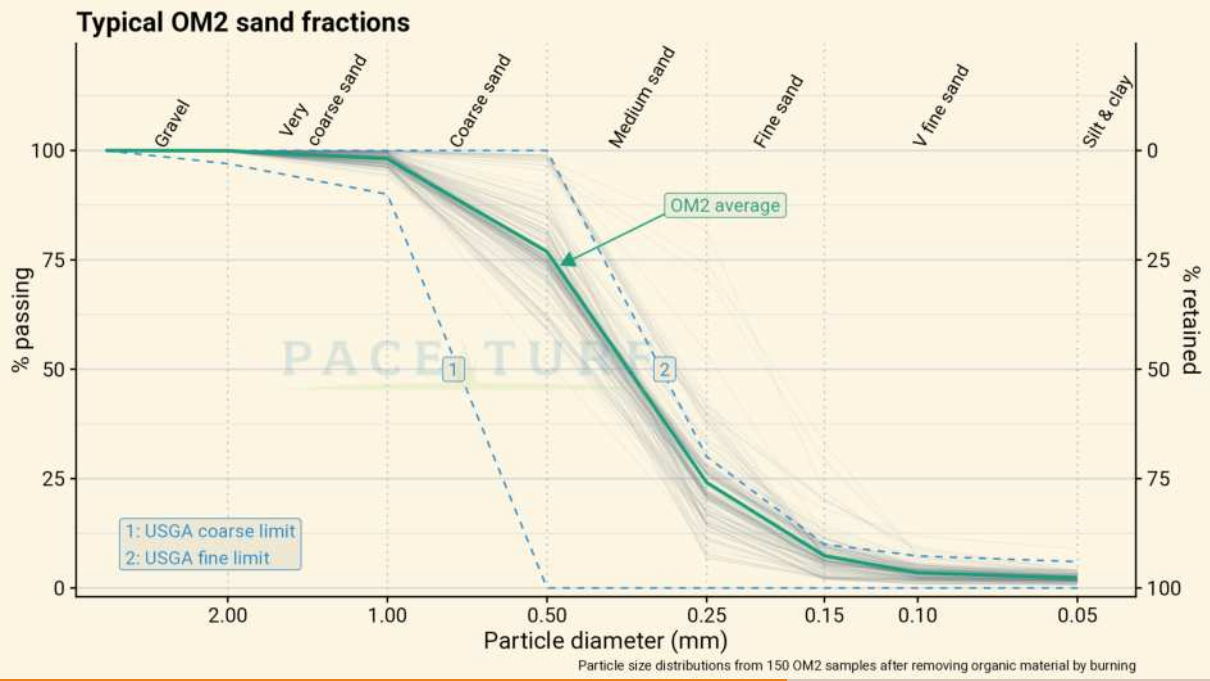
Recommended ranges from the USGA Recommendations for a Method of Putting Green Construction, 2018 Revision

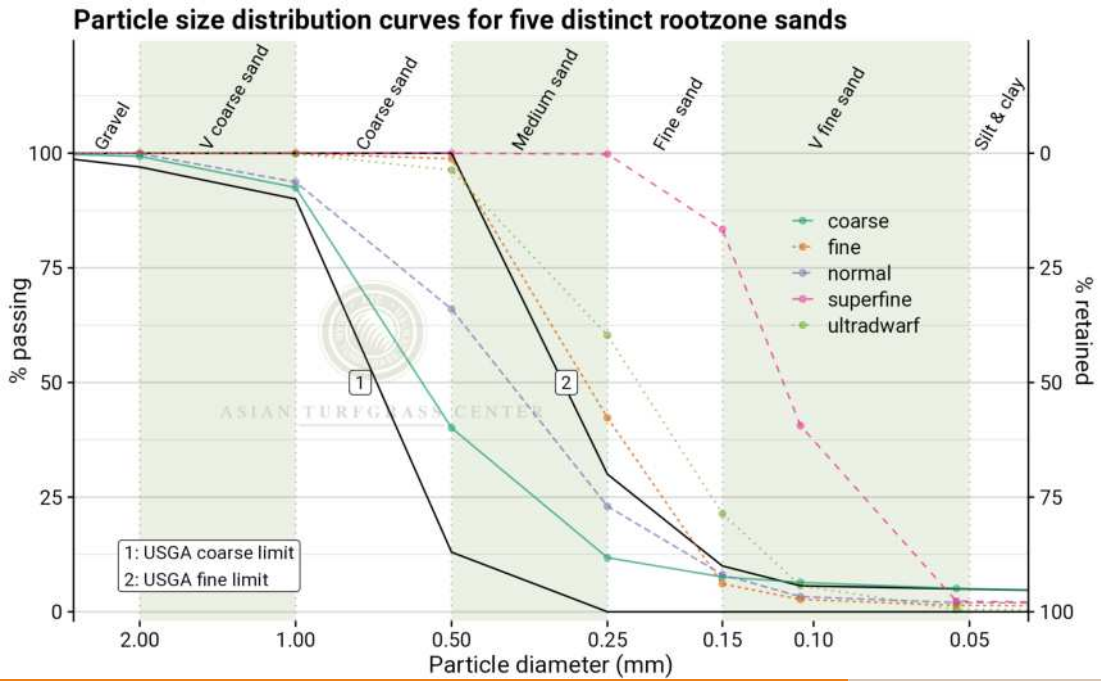
Physical properties

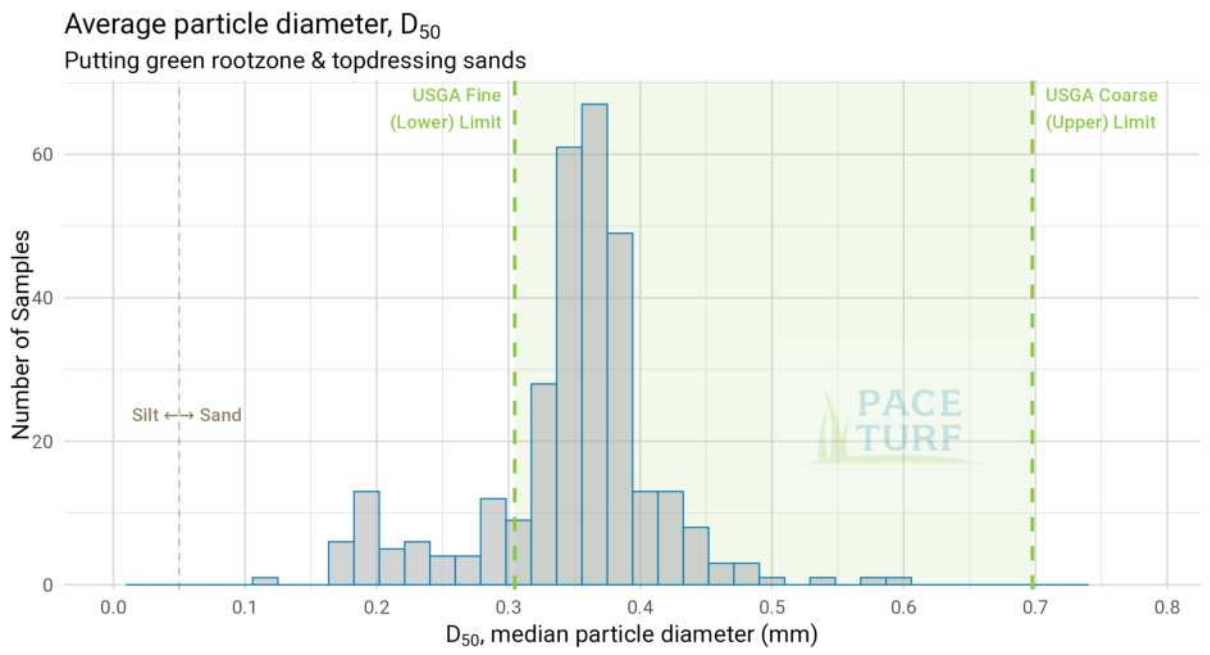

Gravel
V coarse sand
Coarse sand
Medium sand
Fine sand
V fine sand
Silt & clay
100
75
50
25
0
% passing
% retained
0
25
50
75
100
1
2
1: USGA coarse limit
2: USGA fine limit
2.00
1.00
0.50
0.25
0.15
0.10
0.05
Particle diameter (mm)


Gravel
V coarse sand
Coarse sand
Medium sand
Fine sand
V fine sand
Silt & clay
100
75
50
25
0
% passing
% retained
topdress
1
2
1: USGA coarse limit
2: USGA fine limit
2.00
1.00
0.50
0.25
0.15
0.10
0.05
Particle diameter (mm)


Gravel
V coarse sand
Coarse sand
Medium sand
Fine sand
V fine sand
Silt & clay
100
75
50
25
0
% passing
% retained
RMGC
1
2
1: USGA coarse limit
2: USGA fine limit
2.00
1.00
0.50
0.25
0.15
0.10
0.05
Particle diameter (mm)

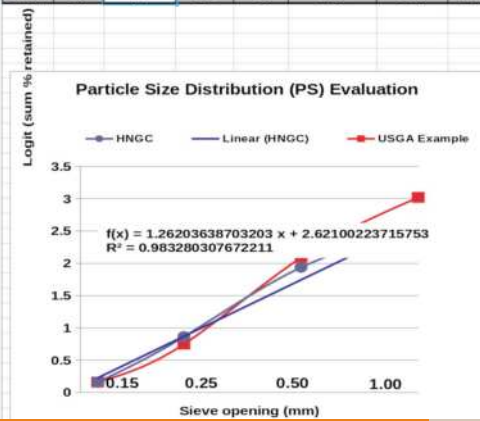

Typical OM2 sand fractions
Gravel
Very coarse sand
Coarse sand
Medium sand
Fine sand
V fine sand
Silt & clay
OM2 average
1
2
1: USGA coarse limit
2: USGA fine limit
% passing
% retained
100
75
50
25
0
2.00
1.00
0.50
0.25
0.15
0.10
0.05
Particle diameter (mm)
Particle size distributions from 150 OM2 samples after removing organic material by burning


Particle size distribution curves for five distinct rootzone sands
Gravel
V coarse sand
Coarse sand
Medium sand
Fine sand
V fine sand
Silt & clay
100
75
50
25
0
% passing
% retained
coarse
fine
normal
superfine
ultradwarf
1
2
1: USGA coarse limit
2: USGA fine limit
2.00
1.00
0.50
0.25
0.15
0.10
0.05
Particle diameter (mm)


Average particle diameter, D_{50}
Putting green rootzone & topdressing sands
USGA Fine
(Lower) Limit
USGA Coarse
(Upper) Limit
Silt ⟷ Sand
PACE
TURF
Number of Samples
0
20
40
60
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
D_{50}, median particle diameter (mm)
Showing 309 different sands from around the world

Instructions: In column "C", enter the name of the sand being tested and the percentage of sand retained on each of the corresponding sieve sizes listed in columns "A" or "B". The target is a regression equation with a slope of more than 1.2 and an R^2 of 0.95 or more. For example: y = 1.2x + 0 and R^2 = 0.95 The slope for this equation is 1.2. For more information, refer to the PACE Turf website at http://www.paceturf.org.

							Logit Transform	
Sieve mm	Sieve No.	HNGC	HNGC	USGA Spec.	log sieve(mm)	sum percent retained	HNGC	USGA Example
0.150	100	14.9	14.9	<20	-1.90	14.9	0.16	0.16
0.250	60	43.0	70.7	>60	-1.39	57.9	0.87	0.75
0.500	35	27.7			-0.69	85.6	1.94	2.09
1.000	18	6.2	6.2	<10	0.00	91.8	2.50	3.02



Chemical

Reference

September, 2014

Minimum Levels for Sustainable Nutrition Soil Guidelines

The Minimum Level for Sustainable Nutrition (MLSN) Guideline is a new, more sustainable approach to managing soil nutrient levels that can help you to decrease fertilizer inputs and costs, while still maintaining desired turf quality and playability levels. The MLSN guidelines were developed in a joint project between PACE Turf and the Asian Turfgrass Center. All soil analyses were conducted at Brookside Laboratories, New Bremen, OH.

	MLSN Soil Guideline
pH	>5.5
Potassium (K ppm)	37
Phosphorus (P ppm)	21
Calcium (Ca ppm)	331
Magnesium (Mg ppm)	47
Sulfur as sulfate (S ppm)	7

Table 1: Summary of ATC database putting green (sands) soil tests for the past five years.

Element	Median	10th Percentile
pH	6.5	
OM	1.29%	
K	59 ppm	23 ppm
P	50 ppm	21 ppm
Ca	499 ppm	261 ppm
Mg	71 ppm	35 ppm
S	9 ppm	5 ppm

- use the right amount of sand
- choose the sand/s you use carefully
- finer sands are generally preferable, but you need enough surface drainage
- sands don’t hold many nutrients, so focus on supplying nutrients in the quantities used by the grass

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