FINAL REPORT:

Laboratory evaluation of SupraSorb rootzone amendment material for sports turf rootzone mixes



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Contents

Summary

The objective of this laboratory trial was to evaluate the efficacy of AustraBlend's amendment material, when incorporated with sand, to produce a suitable sports turf rootzone mix. The USGA Recommendations for a Method of Putting Green Construction provided the standard against which the rootzone mixes were assessed. When the SupraSorb was mixed at 5% and 10% by volume with a USGA sand, the resultant mixes conformed to the USGA Recommendations. At the 15% and 20% amendment rates both mixes were just outside the USGA Recommendations, but both mixes would still have been suitable as sports turf rootzones. The incorporation of SupraSorb resulted in increased cation exchange capacity, especially at the higher amendment rates. Additionally, water retention within the SupraSorb mixes also increased with amendment rate, with the greatest differences between mixes being measured at higher suctions.

Materials and Methods

To be able to test the AustraBlend amendment material (a palagonite clay based material); it was mixed at increasing incorporation rates with a sand to produce a series of rootzone mixes. The sand used was compatible with the USGA recommendations. Additionally, the unamended sand and a commercially available USGA rootzone mix were also tested, so as to provide reference points for the comparison of the performance of the SupraSorb amendment material. All mixes were subject to physical and chemical analyses to assess their relative performance.

Treatments

The following rootzones were tested during the trial:

1. Unamended sand as a control treatment
2. Sand with 5% amendment
3. Sand with 10% amendment
4. Sand with 15% amendment
5. Sand with 20% amendment
6. A commercially available USGA mix (same sand as used above but with a compost amendment material mixed in at a relatively high rate – approximately 30% by volume)

When making up the rootzones with the sand and SupraSorb amendment, all proportions were on a volumetric basis.

Assessments

Particle size distribution

The proportion of different sand sizes, in addition to silt and clay content, is very important in determining how a rootzone will perform as both a playing surface and growing medium. The particle size distribution of the various rootzone mixes was established according to ASTM F1632 (American Standard Test Method).

Saturated hydraulic conductivity with porosity

Saturated hydraulic conductivity is a direct measure of the drainage potential of the rootzone, whilst porosity data helps to describe the balance of drainage pores with those that will hold on to water after gravitational drainage has occurred. These properties were measured according to ASTM F1815.

Water retention and water release curve

Water retention is a key characteristic in that a balance must be struck between providing a rootzone material that allows good water drainage, whilst at the same time retaining enough water to allow healthy grass growth. It was measured by sequentially increasing the degree of suction placed on prepared samples of each mix and determining the water content of the mix at each suction (expressed as a negative tension in kPa). This property does not specifically form part of the USGA Recommendations but is very useful characteristic to measure to help optimise amendment rates.

The water release curve was drawn by calculating the proportion of water remaining in the mixes as increasing suction was applied to the samples.

Plant available water content

As its name suggests, this characteristic assesses how much of the water held in a rootzone is actually available to the plant. The method used in this study used an established relationship presented by Baker (1983), and calculated from the porosity data.

Soil chemical analyses

The following soil chemical testing was carried out on each of the rootzone mixes:

Soil organic matter content by loss on ignition by the method given in ASTM F1647
Soil pH and electrical conductivity
Cation exchange capacity using a standard ammonium nitrate flushing method.
Plant available phosphorous, potassium, calcium and magnesium
Carbon to nitrogen ratio

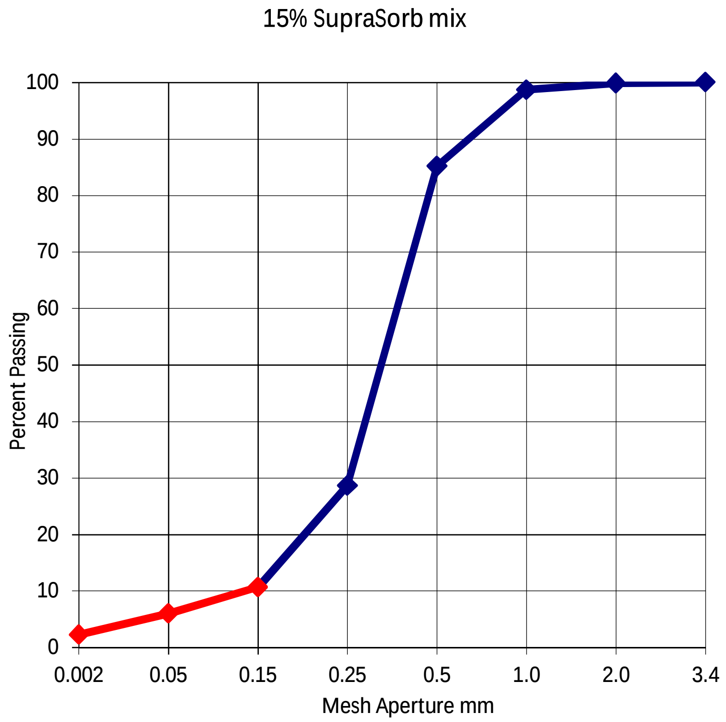
Results

Particle size distribution

The particle size analysis of the unamended sand showed that it was a medium dominant material (Table 1). It would have met the USGA Recommendations, although these are specific to rootzone mixes (amended sand materials). The particle size criteria given in the USGA Recommendations are as follows:

<table>
<tr><th>Size category</th><th colspan="2">Target value</th></tr>
<tr><td>Fine gravel</td><td>≤3%</td><td rowspan="2">≤10%</td></tr>
<tr><td>Very coarse sand</td><td>-</td></tr>
<tr><td>Coarse + medium sand</td><td colspan="2">≥60%</td></tr>
<tr><td>Fine sand</td><td colspan="2">≤20%</td></tr>
<tr><td>Very fine sand</td><td>≤5%</td><td rowspan="3">≤10%</td></tr>
<tr><td>Silt</td><td>≤5%</td></tr>
<tr><td>Clay</td><td>≤3%</td></tr>
</table>

The mixes where sand and SupraSorb were mixed at 5% and 10% both met the USGA Recommendations for the particle size distribution of rootzone mixes. The mixes with SupraSorb incorporated at 15% and 20% were just outside of the USGA Recommendations for the fines content (combined very fine + silt + clay content), as values were above the maximum threshold of 10% (Fig. 1). Even though these two mixes were just outside the USGA Recommendations for the fines content, they would both have made acceptable rootzone materials. If a sand with a lower fines content had been used both of these mixes are likely to have fallen entirely within the USGA particle size recommendations.



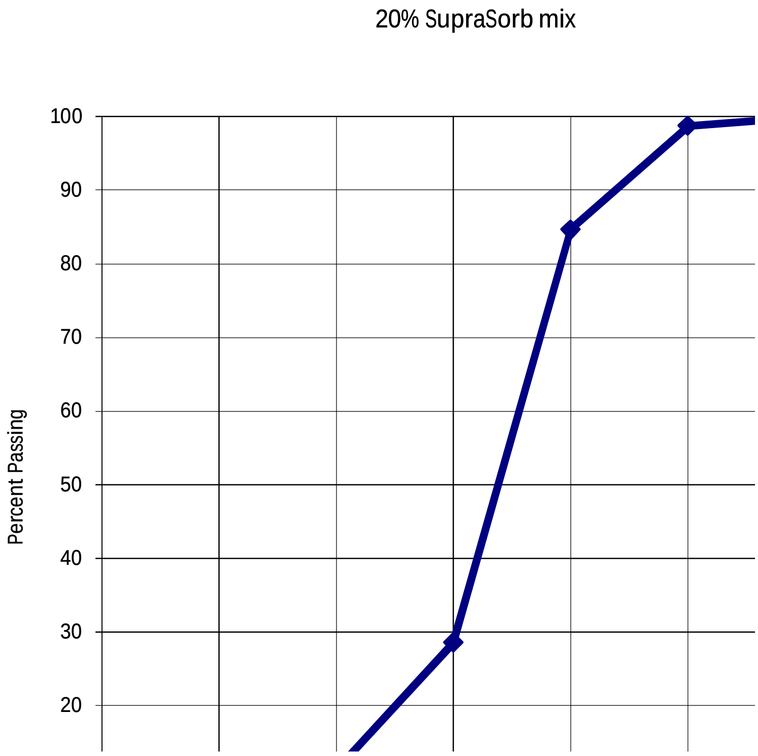


FIGURE 1. Grading curves of the 15% and 20% mixes. Sections in red are those that fall outside the USGA Recommendations (total fines content).

Grading curves of the SupraSorb mixes against the UK Golf Guidelines for rootzone materials are given in Appendix 1 at the end of the report.

The soil organic matter contents of all rootzone mixes reflected the nature of the amendment materials used. The SupraSorb based mixes had generally low organic matter contents due to the primarily inorganic amendment material, whereas the USGA rootzone used compost and therefore had a higher organic matter content.

TABLE 1. Particle size distribution of mixes tested.

Category	Diameter (mm)	USGA rootzone	USGA sand	Sand + 5% SupraSorb	Sand + 10% SupraSorb	Sand + 15% SupraSorb	Sand + 20% SupraSorb
Stones + coarse gravel	>3.4	0.5	0.0	0.0	0.0	0.0	0.0
Fine gravel	3.4 – 2.0	0.3	0.2	0.0	0.0	0.1	0.1
Very coarse sand	2.0 – 1.0	2.3	1.6	1.3	1.3	1.1	1.2
Coarse sand	1.0 – 0.5	14.3	13.4	13.2	13.9	13.6	14.1
Medium sand	0.5 – 0.25	57.7	62.1	60.3	57.4	56.5	56.0
Fine sand	0.25 – 0.15	18.5	18.6	18.8	17.9	17.9	17.3
Very fine sand	0.15 – 0.05	3.5	3.2	3.5	4.0	4.7	4.4
Silt	0.05 – 0.002	1.3	0.9*	1.6	3.4	3.8	4.2
Clay	<0.002	1.6		1.3	2.1	2.3	2.7
Organic matter content (% loss on ignition)		1.19	0.10	0.12	0.18	0.28	0.33
Compliance of material with particle size distribution section of USGA Recommendations		Complies	Not applicable of unamended sands	Complies	Complies	Fails to meet target for total fines (very fine sand + silt + clay content)	Fails to meet target for total fines (very fine sand + silt + clay content)

* For unamended sands a washed sieve test is the standard test method which gives a combined silt and clay content

Saturated hydraulic conductivity, porosity and plant available water content

The target thresholds outlined in the USGA Recommendations are as follows:

Physical property	Target threshold
Saturated hydraulic conductivity	≥150 mm/hr
Total porosity	35 – 55%
Air-filled porosity	15 – 30%
Capillary porosity	15 – 25%

Saturated hydraulic conductivity provides a measure of the drainage capacity of the rootzone mix. Previous research has indicated that a high saturated hydraulic conductivity is needed from a rootzone material to counter the effects of settlement, compaction and organic matter accumulation that can all significantly reduce water drainage rates.

All of the rootzone mixes, apart from the sand + 15% SupraSorb mix, had saturated hydraulic conductivity rates above the 150 mm/hr minimum (Table 2). Even for the 15% SupraSorb mix the average rate was only just below the minimum threshold. It was slightly unusual that the 15% SupraSorb mix had a lower saturated hydraulic conductivity than the 20% mix, although the difference in rates was relatively small and within the variation in drainage rates that can be measured in sand-based rootzones.

Total porosity is a measure of the total void space between the solid components of the rootzone mix. These voids will differ in size, with the larger voids (characterised by the air-filled porosity) playing a crucial role in drainage, whilst the smaller voids (characterised by capillary porosity) tending to be more important for the retention of water. In a good growing medium, there needs to be a balance of both air-filled and capillary porosity so that excess water can drain through the profile, yet some water can be held for use by the grass plants.

With regard to total porosity, all rootzone mixes met the USGA Recommendations. However, the air-filled porosity of the mix containing 20% SupraSorb was just below the USGA target threshold. This was likely to be the result of slightly greater inter-packing of the voids between sand grains by the smaller sized particles (silts and clays). This was also reflected by the capillary porosity for this mix, which, whilst still in target, was higher than for any of the other SupraSorb mixes.

It was unusual that the air-filled porosity of the USGA rootzone mix was significantly below the minimum threshold, whilst capillary porosity was greater than the upper threshold. This anomaly is likely the result of the breakdown of the compost into finer particles during the experiment resulting in the blockage of some of the pore space. However, the presence of larger organic fragments in the compost will have resulted in preferential water flow resulting in the relatively high saturated hydraulic conductivity for this mix.

Plant available water content at -3 kPa tension for all the rootzone mixes was typical of those measured for sand-based growing media. The -3kPa tension is used as it represents the typical installation depth of USGA rootzones and therefore provides data on the available water content to grass plants when the depth of rootzone material is 300 mm. Plant available water content increased in proportion to the water retention characteristics of the rootzone mix and therefore the USGA rootzone and the sand containing 20% SupraSorb had the greatest plant available water content. Plant available water contents did not increase markedly from those measured in the unamended sand until 15% SupraSorb was added to the mix.

TABLE 2. Saturated hydraulic conductivity, porosity and plant available water content, both at 3 kPa tension.

Category	USGA rootzone	USGA sand	Sand + 5% SupraSorb	Sand + 10% SupraSorb	Sand + 15% SupraSorb	Sand + 20% SupraSorb
Saturated hydraulic conductivity (mm/hr)	475	778	397	250	148	187
Total porosity (%)	38.2	39.7	38.7	37.2	36.7	35.0
Air-filled porosity (%)	8.2	21.7	20.5	18.3	17.1	13.6
Capillary porosity (%)	30.0	18.0	18.3	18.9	19.7	21.4
Plant available water content (%)*	24.0	12.0	12.3	12.9	13.7	15.4
Compliance with USGA Recommendations	No – Air filled porosity to low and capillary porosity too high	Complies	Complies	Complies	No – Saturated hydraulic conductivity slightly too low	No – Air filled porosity too low

* Not part of the USGA Recommendations

Water retention

The USGA rootzone tended to retain the greatest volume of water, due primarily to the water holding capacity of the organic amendment (Tables 3 and 4). As expected, water retention was lowest for the unamended sand. The incorporation of increasing volumes of SupraSorb to the rootzone mix resulted in increased water retention. The mixes containing 15% and 20% SupraSorb resulted in greater water retention than the other SupraSorb mixes. The difference in the volume of water retained in the rootzone between the higher and lower rate SupraSorb mixes tended to be most evident when greater suction was applied to the samples.

TABLE 3. Water retention (% volumetric soil water content) of the various rootzone mixes at tensions between -2 to -6 kPa

Tension (kPa)	USGA rootzone	USGA sand	Sand + 5% SupraSorb	Sand + 10% SupraSorb	Sand + 15% SupraSorb	Sand + 20% SupraSorb
-2	39.6	30.8	30.6	31.0	30.4	29.9
-3	30.0	18.0	18.3	18.9	19.7	21.4
-4	16.5	10.0	11.2	12.7	14.0	14.7
-5	14.3	5.9	8.2	10.1	12.0	12.5
-6	8.8	2.8	4.4	5.6	6.8	7.0

TABLE 4. Water retention (mm water per 300 mm depth of rootzone) of the various rootzone mixes at tensions between -2 to -6 kPa

Tension (kPa)	USGA rootzone	USGA sand	Sand + 5% SupraSorb	Sand + 10% SupraSorb	Sand + 15% SupraSorb	Sand + 20% SupraSorb
-2	118.8	92.5	91.9	93.1	91.1	89.7
-3	90.0	54.1	54.8	56.8	59.1	64.1
-4	49.4	30.0	33.7	38.0	42.0	44.1
-5	43.0	17.7	24.5	30.3	36.1	37.6
-6	26.4	8.3	13.1	16.7	20.4	21.0

The water release curve for the rootzone mixes (Fig. 2) indicate that the difference in water retention between the mixes becomes more evident as tension increases (i.e. more suction is applied). This is due to more of the freely available water in the larger pores draining away at low tensions and therefore mixes which have more of the larger pores will hold on to less water as the applied tension is increased. In other words, those mixes which have greater proportion of smaller pores or with organic amendment, which naturally holds onto moisture, will retain a greater volume of water within their pore space compared to mixes with a greater dominance of large pores.

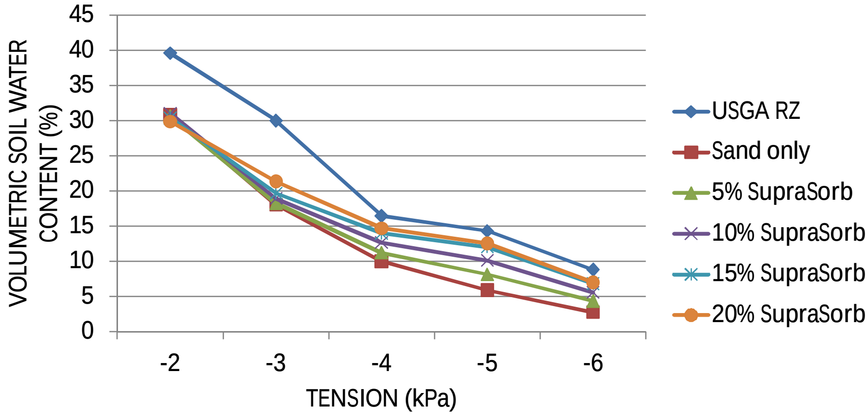


FIGURE 2. Water release curves for each of the rootzone mixes.

Soil chemistry data

The pH of the rootone mixes were neutral to very slightly alkaline (Table 4). Rootzone pH tended to increase with the rate of SupraSorb amendment. Due to the sandy nature of the mixes, they would naturally have a low pH buffering capacity and as a result pH will tend to quickly change in response to rainfall and nutrient inputs. The buffering capacity will increase as the number of potential cation exchange sites increases, as was measured when the incorporation rate of SupraSorb increased.

Readily available phosphate was naturally high in the USGA rootzone due to the compost used as the amendment material. Phosphate also tended to increase as with the volume of SupraSorb in the mix. Overall levels of phosphate in the rootzone mixes was good, whilst potassium concentrations in all mixes, except the USGA rootzone, were relativley low. Magnesium and calcium were relatively abundant in all the mixes, with concentrations of both elements increasing, when compared to the unamended sand, on incorporation of SupraSorb. The C:N ratio was low for all mixes.

The cation exchange capacity of the mixes reflected the increasing rate of the SupraSorb amendment. The CEC of the unamended sand was 2.0 meq/100g, whilst this only increased to 2.4 meq/100g for the organic matter amended USGA rootzone. However, when the SupraSorb was amended into the sand the CEC of the resultant mixes ranged between 3.2 – 8.0 meq/100g. Typical CEC values for a sand based rootzone range between 1 – 4 meq/100g.

Electrical conductivity readings from the pure sand and the SupraSorb mixes ranged between 2.15 – 2.20 mS/cm, which is within the normal range for sports turf rootzones. Values from the organic amended USGA rootzone were slightly higher than normal at 2.60 mS/cm, although still below the threshold where grass growth would be affected.

TABLE 4. Soil chemistry data from the individual rootzone mixes

Soil chemical test	USGA rootzone	USGA sand	Sand + 5% SupraSorb	Sand + 10% SupraSorb	Sand + 15% SupraSorb	Sand + 20% SupraSorb
pH	6.7	6.7	6.9	7.1	7.2	7.2
P_2O_5 (mg/l)	>166	17	53	80	120	>166
K_2O (mg/l)	>241	19	17	14	17	14
Mg (mg/l)	172	165	239	261	313	299
Ca (mg/l)	1001	769	881	905	826	828
Organic matter content (% LOI)	1.2	0.1	0.1	0.2	0.3	0.3
Total N (%)	0.05	0.02	0.01	0.01	0.02	0.04
C:N ratio	13.8	3.8	7.5	8.4	7.4	4.8
CEC (meq/100g)	2.4	2.0	3.2	4.4	6.4	8.0
Electrical conductivity (mS/cm)	2.6	2.2	2.2	2.2	2.2	2.2

Discussion

The laboratory analysis of the AustraBlend amendment material revealed that, when mixed with an appropriate sand at the appropriate amendment rate, it would meet all of the requirements of the USGA Recommendation. With the sand used in this trial, incorporation rates of 5 -10% SupraSorb resulted in mixes that conformed to all elements of the USGA Recommendations. However, incorporation rates of 15 – 20% should not be discounted as, even though this mixes did not meet all USGA requirements, the rootzone mixes would have been perfectly suitable to construct sports surfaces. The specification of all rootzones needs to take into account both the sand and amendment components and any change in either will affect the performance of the final mix. It is a standard recommendation that for any project, once the rootzone specifications have been agreed, project specific testing of available sands and amendments is carried out to determine the optimum mix ratio of both components to produce a mix with the desired physical and chemical properties.

The incorporation of the SupraSorb based material resulted in greater water retention then the sand alone, especially at higher suctions. The USGA rootzone, which had an organic amendment, tended to hold more moisture at each tension than the SupraSorb amended mixes. However, the incorporation rate of the organic amendment in the USGA rootzone was greater than that of any of the SupraSorb treatments, but within the normal range of amendment mixing ratios for many sports turf rootzones.

When the SupraSorb was incorporated into the sand, the cation exchange capacity of the resultant mixes increased linearly with increasing amendment rate. When the SupraSorb was added at 20% by volume the CEC of the rootzone mix was increased fourfold, as compared to the pure sand. The organic amendment did not increase the CEC of the rootzone markedly from that measured in the pure sand.

When looking at potential rootzone mixes, it might be interesting to look at incorporating both the SupraSorb material and some organic amendment as this might take advantage of the properties of both. By producing a sports rootzone with both organic and SupraSorb amendments, the water holding capacity and the CEC of the mix would likely be greatly improved. The choice of organic amendment should be made carefully to ensure it is stable and provides the right physical and chemical characteristics.

The trial data would tend to indicate that the use of the AustraBlend's SupraSorb based amendment could be used successfully in sports turf rootzone mixes and would have the benefits of increasing water retention and CEC without having to add large volumes of organic material.

The laboratory study has focussed on the physical and chemical characteristics of the rootzone mixes. It must be noted that to make specific comment on the effect of the SupraSorb amendment on playing performance of a pitch or its effect on grass, further field based trials would need to be run.

Signed: Christian Spring (Research Manager)
Date: 17 September 2013

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We confirm that this report is a true representation of the original data collected and that the Standard Operating Procedures referred to in the STRI Manual of Standard Operating Procedures, and those relevant to data collection, data preparation, archiving of data and preparation of reports have been implemented in full.

Prepared by: Christian Spring (16 September 2013)

Checked by: Christian Spring (19 September 2013)

Final version checked and reviewed by (20 September 2013)

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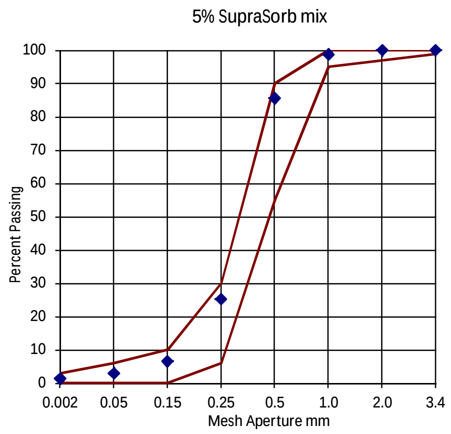
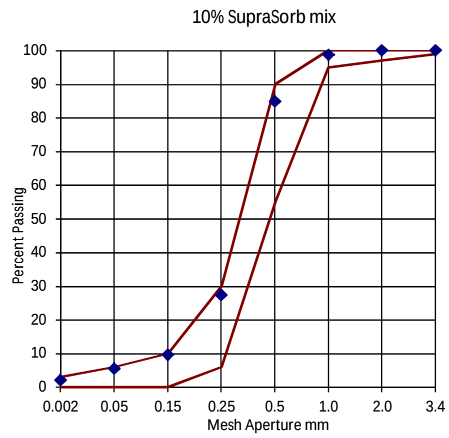
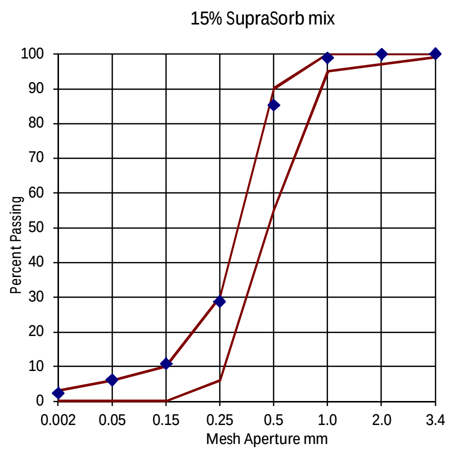
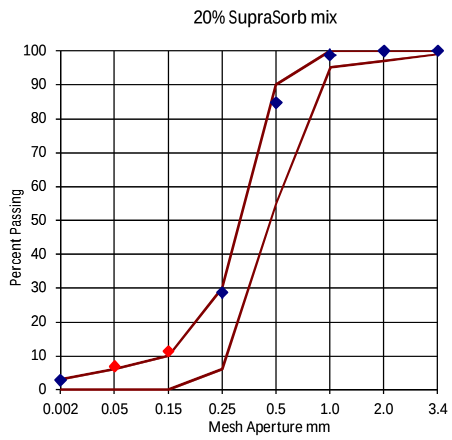
Appendix 1: Grading curves of the SupraSorb mixes









Grading curves of the SupraSorb mixes. The upper and lower limits are from the UK Golf Guidelines, which are modified from the USGA Recommendations. Any points that fall outside the limits are coloured in red.