

E-STAPLE[®]

A new biodegradable anchoring staple

e-STAPLE[®] - Unique 100% Biodegradable Turf Staple

American Excelsior Company's E-Staple - 100% biodegradable turf staple is not just another turf staple. E-Staples are the result of years of research and development that have produced the most unique turf staple available today.

COMPOSITION OF E-STAPLES

E-Staples: Common plastics originate from fossil fuels, but E-Staple is a natural plastic that originates from materials that are abundantly grown in the United States. E-Staple is a Polyhydroxyalkanoate (PHA) plastic that is made from plant sugars and vegetable oils. Bacterium *Ralstonia eutropha* converts sugars directly into plastic in the case of PHA.

PROCESSES OF BIODEGRADATION

E-Staples: biodegrade from microbial attack, which is a surface erosion mechanism. E-Staples degrade in cold (43 °F) to hot (180 °F) conditions and do not require a pre-hydrolytic reduction in molecular weight for degradation to begin. Bacteria in the soil breakdown E-Staples, thus E-Staples breakdown faster in more fertile soils. E-Staples will degrade completely from the soil in 8 to 24 months.

Starch Based Blends, Polyvinyl Alcohol, and Polylactic Acid (PLA): These products require a pre hydrolytic reduction in molecular weight followed by microbial attack of lower molecular weight species. This generally requires a hot (140 °F - 149 °F) and moist composting step, which is not a common condition for soils where turf staples are used. These materials dissolve or swell in water to cause mechanical degradation of the sample followed by slow bacterial or fungal breakdown.

Oxobiodegradable Products: Products that require the polymer to be exposed to heat and/or light so the polymer can be reduced by a radical mechanism with the introduction of high levels of oxygen groups. Oxobiodegradable products are responsive to microbial attack only after pre-exposure conditions are met. The pre-exposure requirements are temperatures of 158 °F to 176 °F lasting weeks to months. These conditions rarely occur in soils where turf staples are used.

UNIQUE PROPERTIES OF E-STAPLE

- Biodegrade in cold (43 °F) to hot (180 °F) conditions
- 100% biodegradation from bacteria (in accordance to ASTM 5338 and ASTM 5271)
- Do not require a pre hydrolytic reduction in molecular weight for degradation to begin
- Water resistant and do not soften from moisture during storage

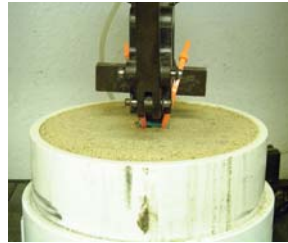
E-Staple® - Unique 100% Biodegradable Turf Staple

Independent Testing Proves E-Staple's Superior Anchoring Strength...

4 in and 6 in E-Staples were tested along with other common products that are used to anchor rolled erosion control products and turf.



Insertion



Flush with Surface



Pulling out

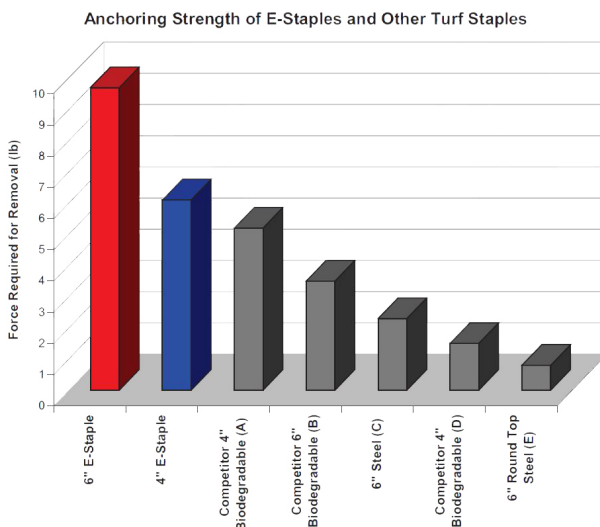
All staples were installed into soil pots that were compacted to $90 \pm 3\%$ of standard Proctor at a soil moisture within 3% of optimum content as per ASTM D698. Staples were mechanically installed at a rate of 50.8 mm per minute. After one minute, the staples were extracted vertically upward at a rate of 50.8 mm per minute, while measuring the force required.

RESULTS:

6 in E-Staples provide 1,212%, 647%, 422%, 277%, and 187% more anchoring strength than 6 in Round Top Steel Staples (E), Competitor Biodegradable 4 in (D), 6 in Steel Staples (C), Competitor Biodegradable 6 in staple (B), and 4 in Competitor Biodegradable (A), respectively!

4 in E-Staples provides 763%, 407%, 265%, 174%, and 117% more anchoring strength than 6 in round top Steel Staples (E), Competitor Biodegradable 4 in (D), 6 in Steel Staples (C), Competitor Biodegradable 6 in staple (B), and 4 in Competitor Biodegradable (A), respectively!

Anchoring Strength of E-Staples and Other Turf Staples



Important Physical Features of E-Staple

