Advanced Turf® is a dynamic solution to the problem of trafficked or load bearing grass areas. It was developed in the UK following extensive research carried out by the Civil Engineering Department at Strathclyde University and the Turfgrass Science Department at Texas A&M University, USA, in conjunction with Netlon Ltd.

The result is an engineered natural grass surface with high load bearing characteristics, improved damage resistance and a unique cultivation property which overcomes the problem of soil compaction.

The Advanced Turf® system consists of conventional grass grown on a selected rootzone material which is reinforced with randomly oriented polypropylene mesh elements. (fig.1)

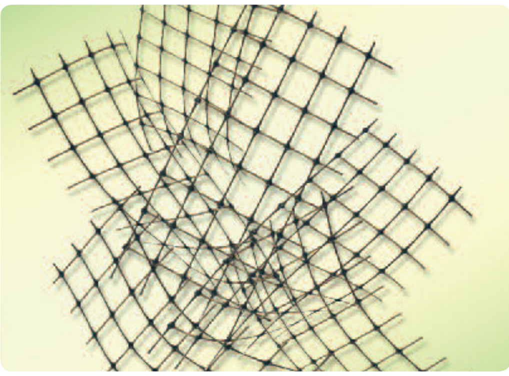

Fig 1: Advanced Turf mesh elements

The small mesh elements, each 50mm x 100mm in size, are blended uniformly with a selected high sand content rootzone medium. The mesh elements reinforce the rootzone medium, increasing strength, maintaining permeability and aid resistance to compaction.

When the grass is established the roots penetrate and entwine with the mesh elements, further stabilising the system and providing positive anchorage for the grass plants. (fig. 2)

Fig 2: The secret of Advanced Turf® is the inclusion of mesh elements in a selected rootzone medium.

The principle involved is that the polymeric mesh elements interlock with groups of soil particles, thereby providing tensile resistance to the soil matrix. The random arrangement of the mesh elements produces a highly isotopic reinforced soil mass. Most importantly, this increase in strength is achieved without any reduction in permeability or ductility. (Hytiris, 1986).

This unique combination of soil reinforcement and improved agronomical properties offers specifiers an environmentally attractive solution to the problems of trafficked grass areas where grass has been deemed unsuitable or the existing grass surfaces have failed due to misuse.

Further research carried out by Strathclyde University, Civil Engineering Department in 2002 showed that in comparative reinforcement tests, the Netlon mesh elements provided a significant improvement (>35%) in their reinforcing effects (load bearing capacity) to that of all 'fibre' type reinforcement products.

Advanced Turf Facts

Advanced Turf® rootzone technology provides:

» a natural turf surface with unrivalled load bearing characteristics and resistance to rutting

» excellent SuDS compliant drainage - surface is never saturated

» built-in resistance to soil compaction

» a safe, firm and attractive environmentally friendly surface

» increased wear tolerance and accelerated recovery of damaged turf

» sustainable economical alternative to hard paving

The mesh elements which give Advanced Turf® its unique structural integrity were specially developed by Netlon Limited, the manufacturers of geogrids used extensively in civil engineering. They are made from polypropylene, selected for its durability and flexural stiffness - the vital characteristics which give Advanced Turf® a unique, durable strength. Polypropylene is non-toxic, insoluble, non absorbent and inert to any of the chemicals likely to be found in a turf rootzone.

The surface is stable, but not hard, and the mesh elements present no danger or trip hazard to people or animals.

Turfgrass Research

To establish the agronomical properties of ATS rootzone, research was undertaken at Texas Agricultural Experimental Station. Based on eight major field plot investigations Prof. Beard, (1993) established a number of significant effects due to the inclusion of mesh elements, which are relevant to areas subjected to vehicle or pedestrian trafficking:

1. Improved damage resistance and recovery rate (50% reduction in recovery time)
2. Improved drainage performance (increased infiltration and percolation rate) (fig. 3)
3. Increased soil moisture (up to 50% increase in available soil moisture) (fig. 4)

Study of thinly sectioned undisturbed samples of rootzone under the microscope revealed the presence of air voids around the mesh element ribs in almost every case.

It is hypothesised that these interconnected voids are created as the mesh elements flex in the soil

Advanced Turf®

Technical Research

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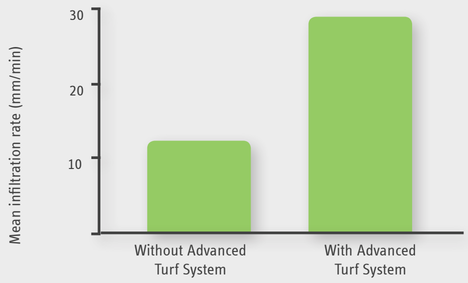


Fig 3: Increased infiltration rate of a fine sand rootzone after 3 years' turf culture. (after Beard and Sifers, Texas A & M University)

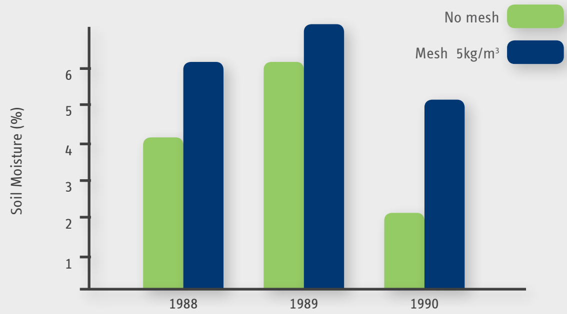


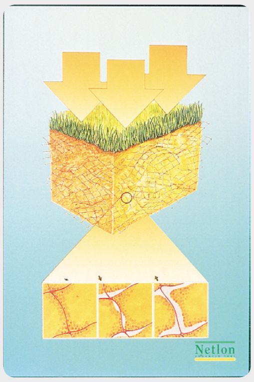
Fig 4: The inclusion of Advanced Turf® mesh elements increases the moisture retention of a sand rootzone (after Beard and Sifers).

Fig 5: Self Cultivation

When the turf rootzone is compressed by trafficking, the mesh elements act as thousands of springs.

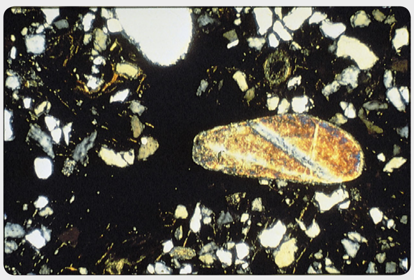
The flexing action creates and maintains voids along the length of the mesh filaments.

This "self-cultivation"action ensures that Advanced Turf® rootzones are healthier than those associated with ordinary turf with a built in resistance to soil compaction.



Microscopic examination shows interconnected voids created by the mesh elements, which maintain an adequate supply of oxygen deep into the rootzone and vent waste gases.

Water can pass more rapidly throughout the rootzone, whilst at the same time the confinement of soil particles within the mesh apertures enhances capillary water retention.



Source: Department of Soil and Crop Sciences, Texas A & M University (Dr.J. B. Beard and Mr. M. De Pew)

under the action of traffic (fig 5). The presence of the voids may explain the improved drainage and the better health of the grass plants.

This "self cultivation" property is believed to be unique to the use of mesh elements. The stiffness characteristics and dimensional stability of the mesh are critical to its performance in this respect.

The development of a natural grass surface based on an engineered rootzone provides an opportunity to design grass surfaces for vehicular traffic or frequent pedestrian use. (fig. 6). Areas of application include:

- roadside verges
- airport verges & helipads
- overspill car parking
- pedestrian / landscaping areas
- fire / HGV access & other occasional access roads
- multi-use events/sports areas
- Steep slopes

Fig 6: Typical section detail

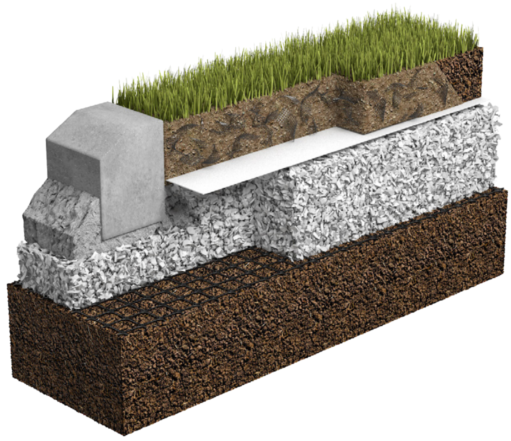


Fig 7: Advanced Turf distributes loads more efficiently to resist rutting

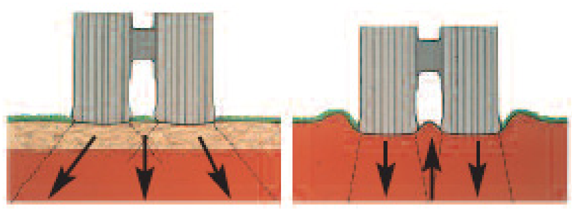
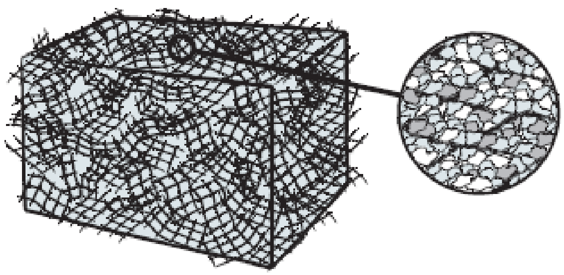


Fig 8: Soil particles interlock within mesh apertures to form an aggregation. Adjacent soil/mesh aggregations then interlock to form a coherent stable matrix.



Soil Mesh Element Interaction Mechanism

When a soil mass is subjected to stress, tensile strains may develop within that soil mass. When mesh element inclusions are present in the zones of tensile strains, they are strained and develop tensile resistance.This leads to an increase in the overall load carrying capacity of the soil mass. (Mercer et al, 1984). The mechanism by which this stress takes place between soil and mesh elements depends upon the soil particles penetrating through and interlocking with the mesh structure. This mechanism is much more efficient than surface friction as employed in fibre based systems.

During compaction the mesh structure deforms locally as the soil particles are packed into the mesh apertures. This deformation sets up tensile stresses in the mesh ribs. After compaction,the mesh attempts to return to it's original dimensions but its prevented from doing so by the soil particles packed within the mesh apertures referred to by McGowan (1990) as "dynamic interlock". The resilient properties of the mesh elements ensure that these tensile stresses are sustained in the long term. The additional confining stress imposed on the soil provides a further strengthening effect.

Engineering Research

In order to understand the operational mechanisms and levels of soil improvement, investigations have been carried out including shear box, triaxial, CBR and footing tests. The sand only sample on the right (fig. 9) shows no evidence of aggregation at high strains.

Fig 9: Triaxial testing of sand samples. The interlocking aggregations are clearly visible as bulges in the sand sample (left) containing mesh elements. The sand only sample (right) shows no evidence of aggregation at high strains.

A significant feature of the triaxial testing was the appearanceof the stabilised samples compared to those of the soil alone. Triaxial testing of Leighton Buzzard sand (fig. 10) compared sand containing mesh elements and sand only samples.

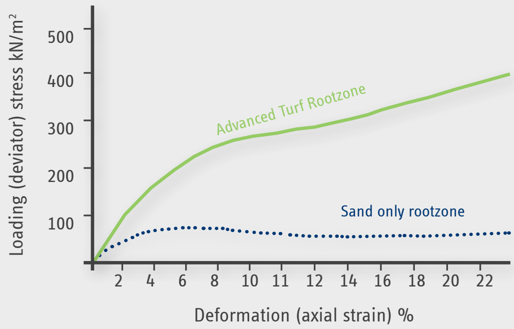


Fig 10: Results of triaxial testing of Leighton Buzzard sand increased strength due to inclusion of mesh elements.

California Bearing Ratio testing showed that CBR values improved steadily as mesh content increased. A series of plane strain model footing tests were conducted to ensure that the strength improvements observed were not limited to the above test methods.

These tests indicated that with a layer of mesh element stabilised soil present, the bearing pressure increased for any given settlement and that deep treatment of soils is not necessary. Furthermore, the mesh inclusions increased the ductility of the soil, a factor previously noted in the triaxial data.

Another significant factor noted was that when unloading the footing tests, almost 20% of the imposed settlement was recovered, which was four times that of the soil alone. This improved recovery of the system is important, particularly where repeated loading occurs. (fig. 11)

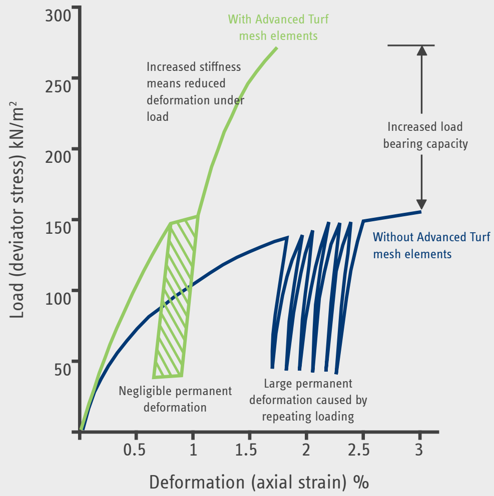


Fig 11: Triaxial testing with repeated loading (6 cycles). Improved bearing capacity and reduced deformation of a sand rootzone under load. (University of Strathclyde)

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2014: Netlon brand owners Conwed Plastics NV commissioned further research to supplement the existing 45 Published Research Papers on Mesh Elements