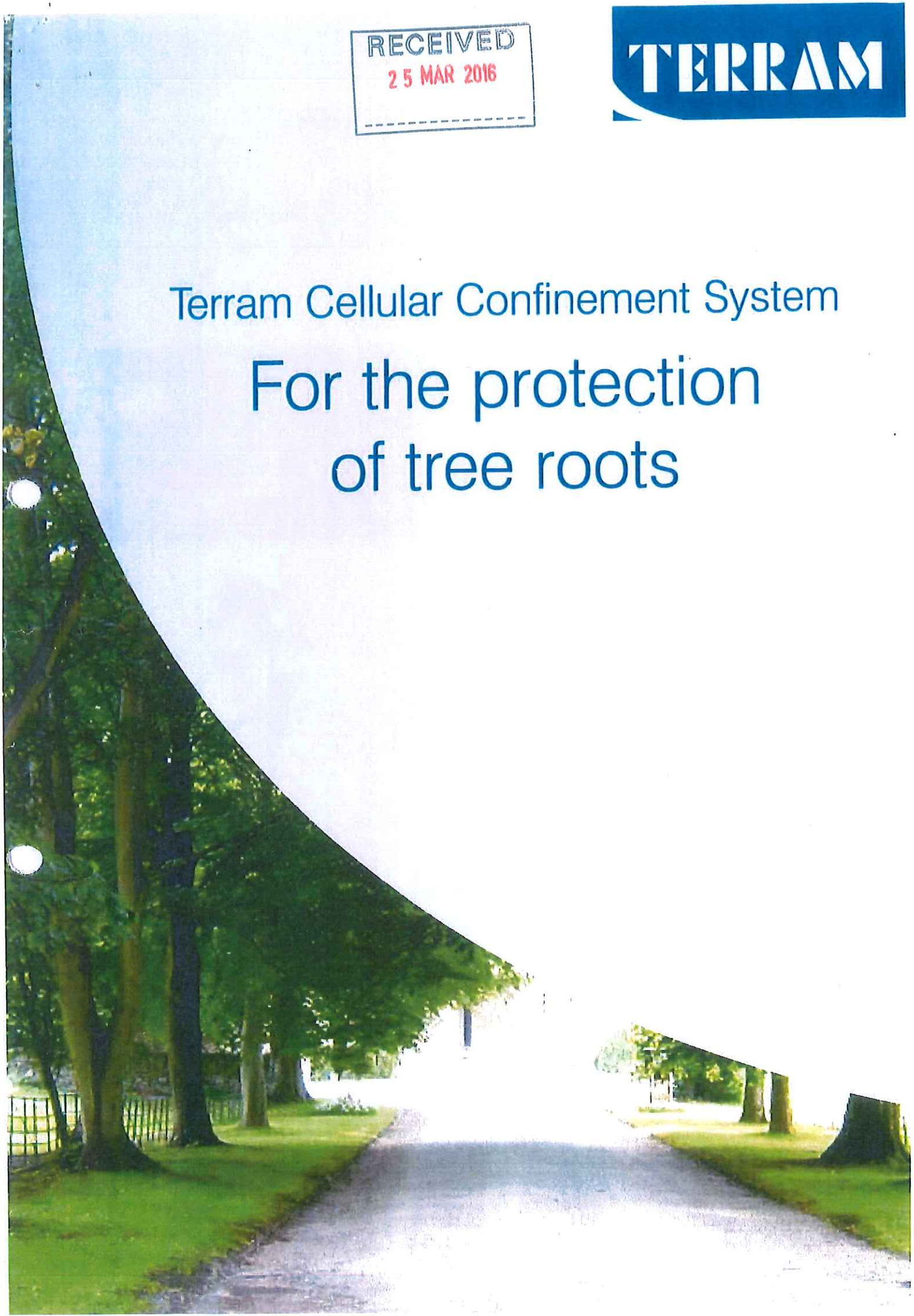
RECEIVED
25 MAR 2016

TERRAM

Terram Cellular Confinement System

For the protection of tree roots



Cellular Confinement Systems

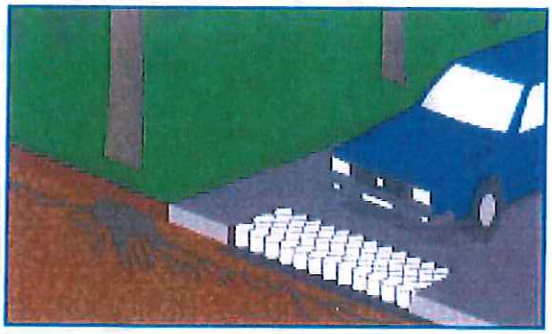
The perfect no-dig ground reinforcement system. Provides above-ground load bearing for paths and driveways whilst preventing soil compaction and protecting tree roots.

Damage to tree roots during driveway construction

The conventional method for constructing paths, drives and roads involves excavating soil to enable the installation of a sub-base that will adequately support traffic loads. Unfortunately this method of construction can badly damage trees since a by-product of the excavation is root severance. Most people don't realise that trees are very sensitive to disturbances in the soil around them. The reason for this is that, contrary to popular belief, trees do not have massive roots that go down deep into the soil but rather have lots of relatively small roots (frequently only a few centimetres in diameter) which spread out from the tree very close to the soil surface for quite large distances (often equal to the height of the tree).

If you imagine a tree system as a wine glass standing on a dinner plate you will have a roughly accurate idea of the above and below ground proportions of a tree (Figure 1). It may come as a surprise to learn that about 80-90% of all tree's roots are in the upper metre of soil (Figure 2). These roots serve two purposes: anchorage and absorption of moisture. If even relatively small roots are severed, for example by digging a trench, the tree can begin to suffer symptoms of drought stress as it is no longer able to obtain all its water needs. In addition the tree may become unstable as cutting the roots is a bit like cutting the guy ropes on a tent.

It is not only root severance that may harm trees but also compaction of the soil. If the root zone of a tree is not protected during development then the soil may become compacted by vehicles or heavy machinery moving repeatedly over the ground (Figure 3). The effect of compaction is to close up pores in the soil which contain air and water. The tree's roots then begin to suffer from both a lack of oxygen and a lack of moisture, and, as the soil becomes denser, roots find it hard to penetrate the soil. All this can lead to a dieback of the root system and frequently dieback of the tree. Raising of soil levels has a similar damaging effect as it deprives roots of oxygen and creates a build up of harmful carbon dioxide around the roots.



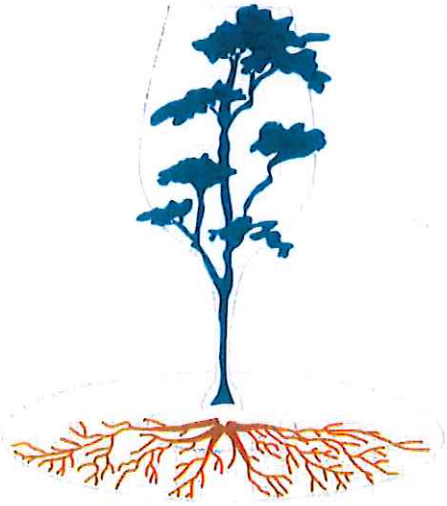


Figure 1

So, How Do Tree Roots Grow?

People often wrongly assume that tree roots are thick and grow down into the soil for many metres (Figure A). In reality tree roots:

- Are usually only large near to the trunk and get thinner the deeper and further from the tree they go. At a distance of just 3-4 metres from the trunk most roots are no bigger than a few centimetres in diameter.
- Spread outwards from the trunk, more or less parallel with the soil surface, rather than growing downwards (Figure B).
- Can spread horizontally in any direction for a distance equivalent to at least the tree's height.
- Are usually relatively shallow; 80-90% of a tree's roots are in the upper metre of soil. Few roots reach depths of more than about 2-3 metres and at this depth they are only a few millimetres in diameter.



Figure A: Incorrect *Figure B: Correct*

Figure 2

British standard for trees in relation to construction and APN1

In recognition of the fact that trees are sensitive to disturbance the British Standards Institution has published recommendations on how to protect trees during development. In line with the earlier British Standard (BS 5837: 1991) the most recent guide, published in September 2005 (see further reading), recommends that there should be a 'root protection area' in which development should not be permitted.

In most cases this area has a radius equal to twelve times the trunk diameter and forms an exclusion zone around the tree protected by means of robust fencing. This guidance had the effect of prohibiting the installation of roads, driveways and parking areas near to trees. But In 1996 the Arboricultural Advisory and Information Service published Arboricultural Practice Note 1 Driveways Close to Trees (APN1) which suggested that driveways could be installed within the root protection area provided roots and the soil were not damaged.

The conditions set out for a suitable system were as follows:

- Roots must not be severed
- Soil should not be compacted
- Free movement of oxygen and carbon dioxide into and out of the soil should be maintained
- Water infiltration into the soil should not be impeded

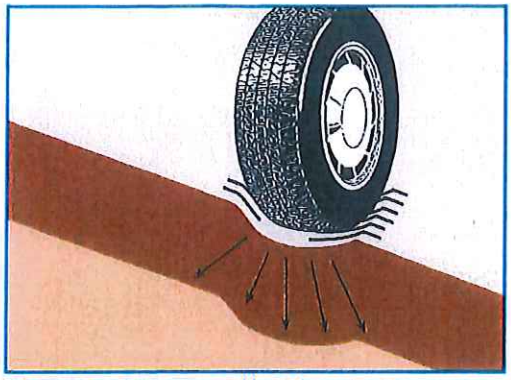
Thus, APN1 advised that driveways could be installed within the root protection zone provided that an above-ground, no-dig construction was used. This advice was incorporated into the recent British Standard which recommended that the most effective means of achieving this was through the use of a three-dimensional cellular confinement system.

Terram Geocell ground protection

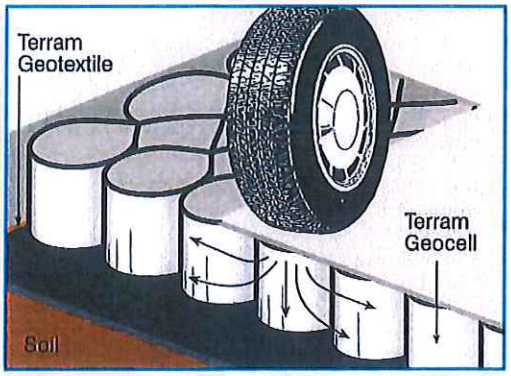
Terram Geocell is an ideal solution for providing ground reinforcement within tree protection areas. It confines fill material within its strong yet flexible cell structure in order to provide a stable base for traffic and an even load distribution (Figures 3 and 4). A big advantage of Terram Geocell over other products is that the geotextile material is permeable and allows lateral movement of air and water.

Terram Geocell is suitable for permanent woodland trails, paths, driveways, roads and parking areas.

It may also be used as temporary ground reinforcement where access to a site is limited by the presence of trees. Once operations on site are completed the temporary surface can easily be removed and the ground left undamaged.



No ground reinforcement: Unreinforced soil becomes compacted and rutted by vehicle loads



Geocell ground reinforcement: Forces are spread laterally reducing loads on the underlying soil

Figure 3. The Geocell distributes loads evenly in order to prevent rutting

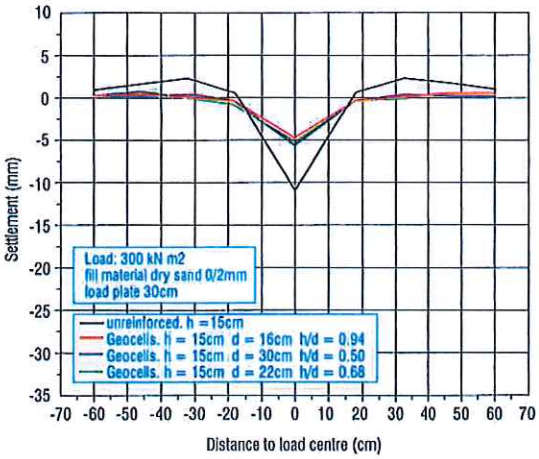


Figure 4. Static loading tests of up to 300kN/m2 revealed only minimal deflection (<5mm) of the surface of filled Geocell

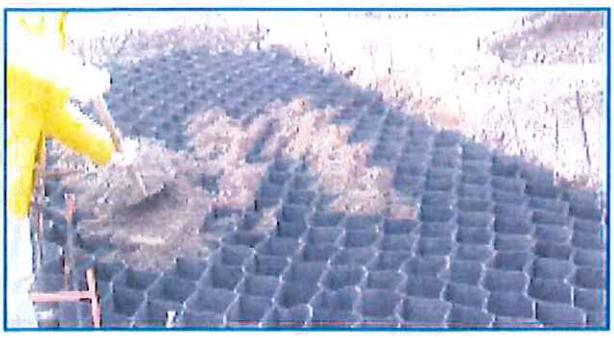


Figure 5

Getting the design right

Every application will be slightly different so it is important to have the input of an engineer and arboriculturist together in order to design the right solution for an installation near to trees. The arboriculturist will be able to advise on tree protection issues and the engineer will be able to specify details such as cell depth, fill type (Figure 5) and load bearing capacity.

For example, the design of a pedestrian footpath may be less rigorous than that of an access road that may have to withstand the load of a heavy crane or a lorry.

But there are some principles that should be considered in every application (see Figure 6):

- The ground must be protected at all stages during installation - there is no point in installing a ground protection system when soil or roots have already been damaged by other site activities
- Terram Geotextile should be used underneath the Geocell to prevent fill materials penetrating the soil
- The fill material should be granular and should permit water and air flow
- Any edgings should be carefully designed to avoid excavation and root severance
- A permeable and gas-porous wearing course should be installed above the Geocell
- In most cases the driveway or parking area should not exceed 20% of the root protection area.

If correctly designed and installed the Geocell cellular confinement system should allow paths, drives and parking areas to be located within a tree's protection zone, thus enabling development that might not otherwise be permitted by local authorities.

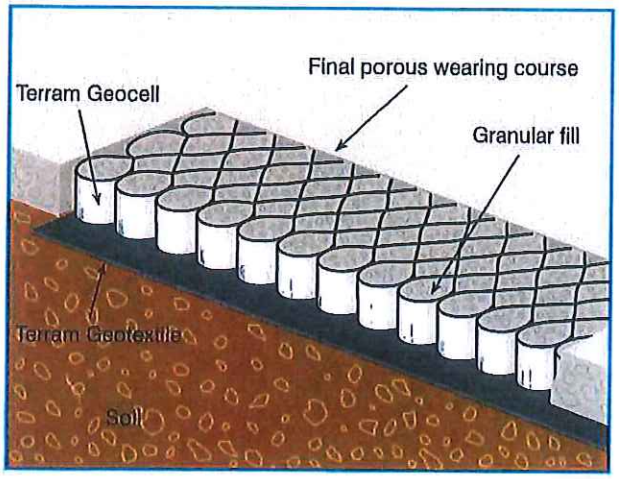


Figure 6. Components of an above-ground load-bearing platform suitable for vehicles

Example installation

Driveway construction

1. Remove grass and other vegetation and the upper organic layer of soil by hand digging. Arisings should be wheel-barrowed out of the tree protection area. Machinery (even low ground pressure tracked vehicles) should not be used due to the danger of soil compaction
2. Small depressions may be filled with sharp sand
3. Lay out Terram Geotextile over the driveway area
4. Lay out Terram GeoCell and carefully peg in place
5. Fill the cells working from the area furthest from the tree first. Further filling should be carried out using the filled Geocell as a platform
6. Install a permeable wearing course, e.g. porous tarmac, block paviours on a sharp sand base (a further layer of Terram above the filled Geocell will be needed in this case to prevent the sand mixing with the granular fill below).

Conclusion

BS5837 Trees in Relation to Construction and APN 1 allow the careful development of paths, drives and roads within the root protection area of trees provided an above-ground, no-dig construction is used.

The use of Terram Geocell as a ground reinforcement platform is therefore an ideal solution that can facilitate such development near to trees which might not otherwise be permitted due to fears of damage to soil structure and tree roots.

Further reading

BS 5837: 2005 Trees in Relation to Construction - Recommendations. British Standards Institution

Dobson, M. (1995): Tree Root Systems. Arboriculture Research and Information Note 130/ARB/95. Arboricultural Advisory and Information Service, Farnham.

Patch, D. and Dobson, M. (1996). Driveways Close to Trees. Arboricultural Practice Note 1. Arboricultural Advisory and Information Service, Farnham.

Nicholson, R. (2001). APN1, BS5837 & PPG 3, Guidance for Trees: Conflict or Complement? Arboricultural Journal 25, 361 - 376.

Products Available	Panel size	Depth	Cell Diameter
Erocell 22/20	5.0m x 10.1m	200mm	220mm
Erocell 25/15	7.0m x 10.0m	150mm	250mm
Erocell 25/10	7.0m x 10.0m	100mm	250mm

The cell depth and diameter is dependent upon specific site conditions

Terram Ltd, Mamhilad, Pontypool, Gwent NP4 0YR, United Kingdom
Tel: +44 (0) 1495 757 722 Fax: +44 (0) 1495 762 393
Email: info@terram.co.uk Web: www.terram.com

Recommendations for use are a guide and purchasers must determine the suitability of the product for their intended use. Terram Ltd assumes no liability for claims beyond the replacement value of our product.

The instructions contained here are a general guide only and therefore cannot cover all aspects involved or all possible uses of Terram Cellular System. If you are not experienced in carrying out projects of the type Terram Cellular System is designed for, you should seek advice from someone appropriately qualified. Any recommendations or suggestions (including design guidance) given by or on behalf of Terram on the use of its products for particular applications are given in good faith and (unless otherwise agreed) free of charge, but it remains your responsibility to ensure the use is appropriate and the product correctly installed.Terram, its agents and employees, accept no responsibility for guidance or advice given.Terram guarantees that this product is in accordance with its specification and if not Terram will at its option supply replacement product or reimburse the price paid for it. This states Terram's entire liability, all other liability and responsibility is excluded. THIS DOES NOT AFFECT THE STATUTORY RIGHTS OF A CONSUMER.