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Memorandum

Subject	Poolend BPS - Ground Protection for Tree Roots
To	James Griffiths
From	Alex Roebuck
Our reference	380854DH34/001
Office	Croydon
Date	27/03/2017
Your reference	380854DH34/001
Technical notes	Discharge of planning requirements - Poolend Arboricultural Survey Report

Terms of Reference

Mott MacDonald was commissioned by Severn Trent Water in 2016 to provide an Arboricultural Survey Report to support the planning application for a proposed new building at its site in Poolend BPS, Macclesfield Road, Poolend, Leek, ST13 8SG. The report (reference: 344035NH06/HWY/HDS/001/E) identified a need for trees 1, 10, 11, 12, 13, 14 and 15 to be provided with ground protection to protect their Root Protection Areas (RPAs) against compaction throughout the construction phase. This memo addresses this requirement and offers solutions to ensure it is met.

Risk to Trees from General Construction Activities

The need for ground protection arises from the fact trees can be easily damaged by construction processes, with both the tree roots and the main structure of a tree susceptible to a range of impacts. Root damage can affect the anchorage and stability of the tree, as well as preventing or inhibiting the absorption of water and nutrients. Damage to the trunk and branches leaves the tree more exposed to disease and decay. In the order of 80% of the roots of any tree can be found in the uppermost 600mm of the soil.

Site Requirements

It is understood that the Poolend site will require the use of a drilling rig for a period of approximately 2 months. The rig to be used will be a Massenza MI-55, this will have a weight of 16 tonnes on the front jack beam and 26 tonnes on the rear jack beam. This will need to be set up within the RPAs of trees 1, 10, 11, 12, 13, 14 and 15. There will be no permanent change in the ground level in this location. The soil will need to be stripped to a depth of 300mm and will be replaced with Type 1 infill.

Tree Summary

The trees that require ground protection are located in the south-eastern corner of the site, adjacent to the A523. They are summarised in the table below;

Table 1: Trees requiring ground protection

Tree No.	Species	Age Class	Height (m)	Stem Diameter (mm)	BS5837 Category	RPA (radius)	RPA (m_2)
1	Oak	Mature	16	570	B	6.8	147
10	Scots pine	Early mature	18	360	B	4.3	58.6
11	Scots pine	Mature	16	650	A	7.8	191.2
12	Scots pine	Semi-mature	15	270	C	3.2	33
13	Scots pine	Semi-mature	14	215	B	2.6	20.9
14	Scots pine	Early mature	18	420	B	5	79.8
15	Scots pine	Mature	20	510	B	6.1	117.7

Summary of Mitigation

To enable construction to proceed with minimum impact on the above trees it is recommended that a product such as Cellweb® (or similar to be approved by Scheme arboriculturalist) is used in conjunction with hand-digging of the area of soil to be replaced. This product has been specifically designed to reduce compaction on tree roots that may be affected during construction. This product would be suitable for the loading requirements expected at the Poolend site. The use of this product or a similar system would enable the construction work to continue unimpeded, as well as enabling the retention and protection of the trees in this location.

It is essential that any tree root compaction protection system is installed in strict accordance with the manufacturer's guidelines and all relevant health and safety requirements. This should also be undertaken in conjunction with the Scheme arboriculturalist. At this stage an Arboricultural Impact Assessment (AIA) and detailed Arboricultural Method Statement (AMS) will be required to produce a specification for construction that can be submitted for approval by the Local Planning Authority (LPA). The following requirements are likely to be included within the final specification:

1. The excavation should be hand dug for the first 1m depth and special care taken within the top 600mm of soil where the majority of the roots are likely to be present
2. Supervision by a qualified Arboriculturalist may be required upon request from the LPA.
3. Any roots<25mm diameter which are exposed by the excavation are to be pruned properly in accordance with good practice using secateurs or a sharp saw; No roots >25mm are to be pruned or severed without prior agreement from the arboriculturalist.
4. Exposed roots should be covered with moist hessian until they are reburied.
5. Any site compound area should be located on a hard-standing surface. If this is not possible then the advice of an Arboriculturalist should be sought to locate the compound outside of any tree RPAs.
6. No digging or movement of heavy plant should be allowed within 1m of the trunk of any tree.
7. All access must be via existing hard standing routes.
8. All plant must operate off existing hard standing if possible otherwise adequate ground protection may be provided to reduce compaction within RPAs.
9. Any works relating to installation of services must be undertaken in accordance with the '*NJUG Guidelines for the Planning, Installation and Maintenance of Utility Apparatus in Proximity to Trees'*.
10. In accordance with good arboricultural practice the following generic recommendations should be followed:
    - No actions to be undertaken that are likely to cause localised water-logging;
    - No permanent alteration of ground levels within the RPA of retained trees;
    - No construction of hard surfaces within RPA of retained trees;
    - No boards, hoarding, cables, notices or fencing to be attached to trees;
    - No fires are to be lit within 10m of tree canopies; and,
    - No handling, discharge or spillage of any chemical substance, including cement washings and vehicle washings within 10m.

If you have any further queries, please contact Rhys Lennon or myself.

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Appendix 1: Cellweb® Datasheet

Tree Root Protection Using Cellweb TRP®

Fact Sheet 1: Use of Cellweb TRP® in Root Protection Areas (RPA's)

Introduction

Cellweb TRP® is a cellular confinement system that confines aggregate materials and makes them stronger. This behaviour allows the depth of pavement construction to be reduced. It also minimises compaction of soils below road pavements constructed using the Cellweb TRP® tree root protection system. Cellweb TRP® is used around the world to provide cost effective road and railway construction, as well as Tree Root Protection.

Cellular confinement was developed by the US Army Corps of Engineers during the 1970s to allow construction of roads for military equipment quickly and easily using whatever local soil material was available (especially across beaches). Since then the method has been developed and it is now routinely used in road and rail construction as well as in tree root protection. There is an extensive research base that demonstrates the performance of cellular confinement and it is a method of pavement construction that is recognised by the US Federal Highways Administration.

Characteristics of Cellweb TRP®

Pokharel et al (2009) stated that about one fifth of pavement failures in the US occur due to either weak subgrades or inefficient load transfer from the sub-base. Cellweb TRP® can improve the strength of road pavement construction to deal with these problems. It is a three dimensional interconnected honeycomb of cells made from HDPE. The cells are filled with aggregate sub-base and laterally confine the material when it is loaded, thus increasing the bearing capacity of the layer. This results in a thinner layer of aggregate being required to achieve the same performance.

It also allows uncompacted open graded aggregate to be used in the sub-base construction which is a vital part of any tree root protection system.

Cellweb TRP® is available in a range of height and aspect ratios to suit different load applications.

Use of Cellweb TRP® in RPAs

The use of Cellweb TRP® tree root protection system for building roads, car parks and other vehicular pathways includes a sub-base infill material of clean angular stone which does not need to be compacted. This immediately provides a layer of material that will absorb compaction energy applied to the top of materials placed over it. Compaction of soils by construction machinery does not extend to a great depth. This is the reason why earthworks materials are normally placed in thin layers because compaction only occurs in the top few hundred mm at most. With the lightweight compaction plant used on most development sites the maximum depth that compaction will extend to is between 150mm and 200mm. Thus, if an 80mm layer of asphalt is placed over a 150mm deep Cellweb TRP® system the compaction reaching the base of the construction and the natural soil will be minimal. This effect was demonstrated by Lichter and Lindsey (1994) where a trial area was trafficked by a front-end loader and only suffered significant compaction of the soil to a depth of 100mm.

The use of Cellweb TRP® also spreads the wheel loads from traffic. There has been extensive research published on the performance of these systems from the original work by the US Army Corps of Engineers (Webster 1981) to more recent studies such as that by Emersleben and Meyer (2008).

Figure 1 • In situ density test prior to construction of pavement

The research shows that Cellweb TRP® acts as a stiff raft to distribute wheel loads and reduce their magnitude at the base of the construction by 30% to 36% (without any asphalt or other surfacing). Once the surface is taken into account, the pressure applied by traffic to soil below roads or pavements constructed using no-dig methods will be significantly reduced and thus compaction will also be reduced. Note, compaction is not prevented but it is reduced, thus maintaining the soil bulk density at levels that are suitable for tree root growth.

The effectiveness of the Cellweb TRP® no-dig construction in reducing soil compaction has been demonstrated in trials carried out by the Environmental Protection Group Limited. Two parking bays were constructed over a fine sand soil, one with a
Cellweb TRP® cellular confinement sub-base. The parking bays were surfaced with asphalt and then used by cars for four weeks on a daily basis. It is well known that compaction of soils occurs in the first few passes of a vehicle, so the maximum adverse effects on compaction of soil below the pavement should have been achieved. In situ density tests were carried out on the sand below the pavement before and after construction (Figure 1).

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Tree Root Protection Using Cellweb TRP®

Fact Sheet 1: Use of Cellweb TRP® in Root Protection Areas (RPA's)

Figure 2 - Cellweb TRP® in construction.

Figure 3 - In situ density tests post-trafficking.

The results in Figure 4 show that compaction of the soil below the Cellweb TRP® pavement was noticeably lower than that below the normal pavement. The increase in compaction below the normal pavement is similar to the increase found on a number of construction sites by Alberty et al (1984).

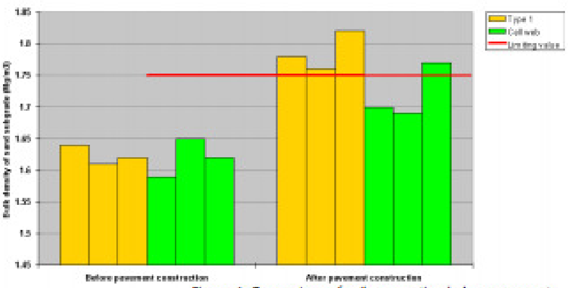

Figure 4 Comparison of soil compaction below pavements

The use of layers of uncompacted material has also been shown by others to reduce compaction of natural soil by construction plant (Lichter and Lindsay 2004). However, these were temporary layers intended to be removed after construction was finished and they are not suitable for incorporation into a permanent car park surface. Nonetheless, it does demonstrate the effectiveness of no-dig techniques using Cellweb TRP®. It is important to note that the specific properties of cellular confinement systems (eg material type, strength, welding at joints, perforations, etc) will affect how each one behaves in trials such as this. Therefore the results are only applicable to the Cellweb TRP® system.

Note

So called tree root protection systems that use Type 1 sub-base or any similar material that requires compaction will not prevent compaction of soils around the tree roots. Type 1 is also not very permeable to air and water and will limit the availability to roots. Therefore geogrid reinforced Type 1 is not suitable for tree root protection.

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Alberty CA, Pellet HM and Taaylor DH (1984). Characterisation of soil compaction at construction sites and woody plant response. Journal of Environmental Horticulture, 2, 48-53.

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Tree Root Protection Using Cellweb TRP®

Fact Sheet 2: Water and Oxygen Transfer Through the Cellweb TRP® System

If the Cellweb TRP® sub-base layer is covered by a layer of permeable block paving the rate of oxygen transfer through the system is estimated to be around 1 x 10-4 g/s/m² using simple diffusion theory. For a natural sandy soil the rate of transfer to the same depth is around 7 x 10-5 g/s/m². Therefore even on the most aerated of natural soils the Cellweb TRP® tree root protection system does not restrict oxygen supply to tree roots.

Water ingress will also be maintained at the levels similar to a natural sites as water simply passes through the pavement. Permeable block paving and porous asphalt have infiltration rates that are very large (typically > 2500mm/h) in comparison with most rainfall events. The infiltration rate is also far higher than natural soils (infiltration rate for sand is quoted as >20mm/h by Hillel 1998). Thus the pavement allows rainfall to soak into the soil as it would naturally (there will be some reduction as some water soaks into the blocks and gravel as the rainfall passes through).

TABLE 1 - CHARACTERISTICS OF ROOT SYSTEMS OF MATURE EUROPEAN BROADLEAVED AND CONIFEROUS TREE SPECIES GROWING ON WELL AERATED, SANDY SOILS

Species	Tolerance to Oxygen Deficiency	Species	Tolerance to Oxygen Deficiency
Ash	Medium-high	Japanese Larch	Medium
Aspen	High	Lime	Low
Birch	Low	Norway Maple	Medium
Beech	Low	Norway Spruce	Very low
Common Alder	High	Red Oak	Medium-high
Corsican Pine	--	Scots Pine	Medium
Douglas Fir	Medium-low	Sessile Oak	High
English Oak	High	Silver Fir	High
European Larch	Medium	Sycamore	Low
Hornbeam	Medium	White pine	Very low

From Roberts et al (2006)

If the Cellweb TRP® is covered by impermeable asphalt or similar materials the aeration of the sub-base can be promoted from the side of a paved area. This is achieved using gravel filled conduits to connect the sub-base to the surface, allowing oxygen into the layer from where it can freely travel to the root area. Open areas that are normally provided immediately around the tree will also be beneficial in allowing oxygen into the Cellweb TRP® layer. Oxygen can flow horizontally through the Cellweb TRP® because of the perforated walls.

Notwithstanding the above, some trees are more tolerant than others to a deficit of oxygen (Table 1). The use of permeable surfaces over the Cellweb TRP® is advisable where pavements are to be constructed over trees with a low tolerance to oxygen deficit.

References

Alberty CA, Pellet HM and Taaylor DH (1984). Characterisation of soil compaction at construction sites and woody plant response. Journal of Environmental Horticulture, 2, 48-53.

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Emersleben, A and Meyer, N (2008). The use of geocells in road construction over soft soil: vertical stress and falling weight deflectometer measurements. Fourth European Geosynthetics Conference, Edinburgh, 7–10 September 2008.

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Tree Root Protection Using Cellweb TRP®

Fact Sheet 2: Water and Oxygen Transfer Through the Cellweb TRP® System

Water and Oxygen Transfer Through the System

Water and oxygen are the lifeblood of trees without which they will wither and die. It is important to design developments in and around the root protection area (RPA) of existing trees to maximise the availability of water and oxygen to the roots. This can be achieved in a number of ways using the Cellweb TRP® tree root protection system.

The main causes of reduced water and oxygen availability for tree roots are:

- Compaction of the soil around the roots
- Covering the ground surface with impermeable cover which prevents water infiltration.

Both of these effects can be reduced or prevented by using Cellweb TRP® tree root protection within an appropriately designed road or car park surface.

Compaction of Soil

The use of Cellweb TRP® tree root protection system for building roads, car parks and other vehicular pathways includes a sub-base infill material of 20mm to 40mm or 4mm to 20mm clean angular stone which does not need to be compacted. This immediately provides a layer of material that will absorb compaction energy applied to the top of materials placed over it. Cellweb TRP® also spreads the wheel loads from traffic which reduces compaction, thus maintaining the soil bulk density at levels that are suitable for tree root growth.

The effectiveness of the Cellweb TRP® no-dig construction in reducing soil compaction has been demonstrated in trials carried out by the Environmental Protection Group Limited (See Fact Sheet 1).

Water and Oxygen Availability

The Cellweb TRP® tree root protection system is constructed using 20mm to 40mm or 4mm to 20mm gravel infill and has perforated cell walls. The pore spaces between the aggregate particles are greater than 0.1mm in diameter and are therefore defined as macropores (Roberts 2006). This open structure is far more permeable than typical soils and allows the free movement of water and oxygen within it so that supplies to trees are maintained as shown in Figure 1. The use of continuous permeable surfacing and intermittent gaps in impermeable surfacing are recognised ways of providing water and air infiltration pathways through a pavement surface into the tree root zone (Ferguson 2005).

The Cellweb TRP® system incorporates the Treetex® geotextile at the base. This is a very robust geotextile that is resistant to puncturing. Crucially for tree root protection it does not have a water breakthrough head that other geotextiles may have. Therefore it will always be free draining and will not limit oxygen availability to the roots.

Breakthrough Head

All geotextiles are by their nature permeable, however in order to develop optimum water-flow performance, some types of geotextiles (eg, thermally bonded types) require a minimum depth of water to develop over them.

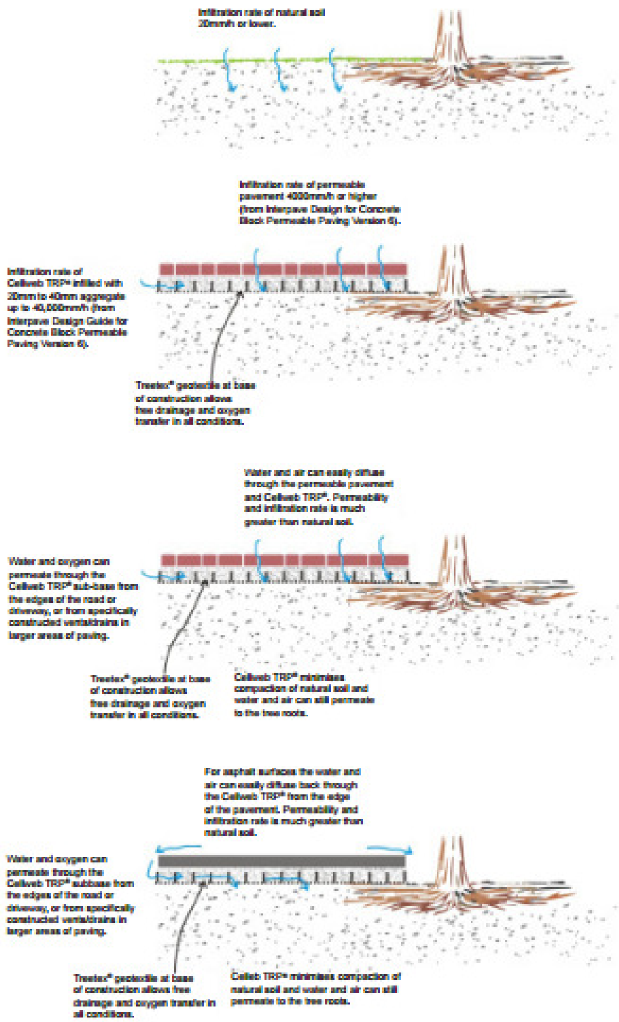

Figure 1 Water and oxygen availability in Cellweb TRP® tree root protection pavements

Therefore a layer of up to 50mm of water can build-up over some geotextiles after rainfall. Treetex® needle punched geotextiles however remains free draining at all times as it has "zero breakthrough head" which means it does not require a build up of water to permeate.

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Source: http://www.geosyn.co.uk/downloads (2017)