
MEMORANDUM

From	Martin Bowman	Date	7 th July 2023
To	Sean Bennett		
Subject	Roof Top Garden Soil - Technical Paper		

Introduction

The requirement for and popularity for buildings to be “greened” with roof top gardens, green walls and planted apartment terraces is growing rapidly as Perth addresses its “heat island” issues and responds to the community’s increasing desire for a greener, softer urban environment.

This trend has seen an increasing construction industry demand for special purpose soil types which can meet the structural engineering requirements for gardens within multi-story buildings, as well provide an optimum growing medium for rooftop plants and gardens.

Eclipse Soils has responded to this market requirement by developing a special purpose light-weight soil designed especially for the structural engineering and horticultural needs of the move to greener buildings and roof top gardens.

The structural engineering issue which arises when a roof top garden is designed is the weight of the garden soil in particular, and especially when the soil has been watered, is wet and therefore heavy.

Floor plates in multi-story buildings are designed to carry specified weight loads which must not be exceeded.

Loadings to floor plates arise from all interior goods within a building and include residential appliances and furniture, residents and their numbers, and garden areas including roof tops, planted decks and terraces, and green walls attached to the building.

The soils used for rooftop gardens are therefore tightly specified so as to meet structural engineering design criteria.

This paper provides a background to the Eclipse Roof Top Garden soil product, presents relevant engineering data, and explains how the benefits of the product derive from its special formulation.

Structural Engineering Basics

It is typical for an engineering specification for a roof-top garden soil to cite a maximum saturated bulk density of 1.2 tonnes/m³.

This means that when saturated with water, the wet soil must not be heavier than 1.2 tonnes for each cubic metre of soil in place in the garden.

To give some context to this figure – the following data are relevant:

- Water has a density of 1 tonne/m³
- Typical dry sand has a bulk density of about 1.6 tonnes/m³
- Typical saturated sand has a bulk density of about 2.0 tonnes/m³
- Rocky stone aggregate has a dry bulk density of about 2.0 tonnes/m³
- Granite rock has a particle density of about 2.6 tonnes/m³

The problem in developing a light weight soil which has a saturated bulk density of 1.2 tonnes/m³ is made clear by these comparative wet and dry bulk density data.

The solution to formulation of a quality light weight soil lies within the use of ingredients which have very low dry bulk density, but have a particle porosity which allows water to be stored in the intra-particle pore spaces.

The Eclipse Rooftop Garden Soil solves this issue by using two specially selected ingredients.

The first is spongolite. This is a naturally occurring material mined in the Great Southern and consists of a soft rocky sediment which has been formed from sponges which grew in an ancient sea which was then infilled with sediments from the surrounding land.

The resultant sediment is highly siliceous, and highly porous as the physical structure of the sponges has been preserved as fine soil particles from the surrounding land washed into the sea and filled it. As the resulting sediments were exposed to air, they have lithified into the material we now call spongolite.

Spongolite has a dry bulk density of about 0.65 - 0.75 tonnes/m³. This is about half the dry bulk density of sand. The very low bulk density is a result of the highly porous nature of the spongolite pieces.

The second ingredient is charcoal. Charcoal is recovered as a waste material from a local industry and is a recycled product.

The dry bulk density of the charcoal used by Eclipse is about 0.3 tonnes/m³. As is the case for spongolite, this very low bulk density, is a result of the highly porous nature of the charcoal pieces.

It is in the intra-particle pore spaces of both spongolite and charcoal where plant available water is stored.

The structural strength of the resulting blend derives from the spongolite pieces, which range in size from about 10 to 20mm diameter and can be classified as a gravel texture. Whilst highly porous, the spongolite pieces are resistant to crushing within the garden soil blend and have the strength of a soft stony material. The charcoal pieces are also resistant to crushing.

The charcoal pieces are all less than 5mm in diameter and the resultant mixture has the texture of a coarse sandy gravel.

A minor percentage of fine compost is added to increase beneficial microorganisms within the soil, along with sandy loam to further increase water and nutrient retention.

When saturated to field capacity the inter-particle spaces are mostly free of water but the intra-particle pores are saturated. This free draining nature of the bulk material contributes to its low saturated bulk density.

The material is thus free draining but has entrained water within the soil blend particles. This is the plant available water within the soil blend.

The wet bulk density of Roof Top Garden Soil is measured at 1.2 tonnes/m³, thus meeting the tight engineering specifications issued for multi-story building plate design.

Comparison to alternative products

The need for light-weight soils has been around for some time and it is valuable to examine how the Eclipse Rooftop Garden Soil compares to alternative products.

Common inputs for alternative light weight soil products include the following:

- Compost and organics
- Vermiculite
- Perlite

Compost and organic based products can provide a light weight growing medium high in nutrients and beneficial microorganisms. Quality compost provides a good structure for root development which retains plant available water and drains freely.

Unfortunately, the benefits of growing media with a high percentage of organics are short lived, as the organic material quickly breaks down, resulting in poor soil structure, poor drainage, water repellence and slumping.

Slumping caused by breakdown of the organics presents major ongoing maintenance costs for Rooftop Gardens, as the growing medium continuously needs to be topped up and replenished to support plants. This is particularly expensive due to the lack of access for the transport of bulk materials available during construction, such as a delivery in bulk bags via a crane.

Vermiculite and perlite are heat-expanded clay products with very low bulk densities and high water retention capacity. While these products provide a high quality base for light weight soils, they are very energy intensive to produce, and as a result are cost prohibitive for bulk soil applications.

Secondly, the inclusion of the ultra-light vermiculite and perlite particles means that installation under windy conditions can cause wind-blown separation of these materials and dispersal through the work-site. This potential will continue after placement in the garden, where windblow from the garden bed surface can occur unless there is a cover layer of stone or mulch.

The Eclipse Rooftop Soil does not have these two issues.

The component materials do not biodegrade, thus providing a permanent growing medium that retains a good soil structure which never needs to be topped up or replaced. There are no ultra-light components of the nature of vermiculite and perlite and wind-blown disaggregation of the Eclipse Rooftop Garden soil blend is not experienced.

In summary, the Eclipse Rooftop soil, is a superior product to historical light weight soil formulations, being both well drained and thus aerated, water retentive, and structurally resilient to slumping over time.

Summary

Eclipse Soils Roof Top Garden Soil is a specially formulated roof top garden growing medium which has high performance in terms of water retention and plant growth whilst also meeting strict structural engineering specifications for saturated bulk density.

It provides a permanent growing medium that will not biodegrade or cause slumping. This removes the need to top up garden beds and significantly reduces ongoing maintenance costs.