

**CS-64 Development and Principles Concerning the Planting of Greenery
on Vertical Walls or Steep-Inclined Concrete Surfaces**

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1. Introduction

One method in which the surfaces of porous concrete can be used for various useful purposes is the use of the concrete as a substrate for planting. The greening of concrete naturally attracts much acclaim for its esthetic appearance and has also been reported to be an effective means of mitigating the temperature changes in the surrounding locations (temperature controlling effect).

In addition to the established planting and greening practices, including roof top cultivation, wall-greening and plant growing on balconies, the greening of porous concrete surfaces by direct planting has now also become possible as a result of the current research and development efforts. For the greening of concrete to make real progress, however, it is essential the application range should be widened. Until the present, plant growing has been limited to flat and gently sloped concrete surface in the interests of retaining the mechanical strength and resistance of the concrete structure, and it ill be important that greening should also be possible on vertical and steeply inclined concrete surfaces which have not been amenable to the conventional greening techniques. A new approach, tried on an experimental basis, is introduced here, highlighting the use of a highly desiccation-resistant plant family known as stonecrop or sedum for covering vertical walls and steep inclines.

2. Conventional Techniques

For the greening of concrete, the conventional techniques have been plant bedding systems in which the surface of the concrete structure is prepared to provide a base for plant growth. One of the established practices is to cast a porous concrete surface on the concrete base and to create a planting bed by filling the air gaps in the porous concrete with a mixture consisting essentially of soil, water-retaining material (moisture absorbent) and fertilizer to permit the growth of plants on the surface of the concrete structure.

The drawback of these systems is that they provide a limited growth bed. As a result, they do not offer the essential moisture required for plant development so that the plant cannot grow adequately. Even when the plant take with successful sprouting and initial growth, they can only rely on the water reserves retained in the air gaps and voids of the porous concrete. This is not sufficient to meet the increased water demand associated with root development so that the plant will either die or wilt without proper development. It is therefore not possible to achieve a satisfactory green cover on concrete structures on a long-term basis although the initial greening of the surface may "hold" for a while.

3. New Developed Technique

The new system has been developed to provide a method for installing the concrete structure and a panel capable of being used for this purpose. It is characterized in that it permits long-term plant growth and eliminates the adverse effect on the plants due to the cast concrete and the leaching of alkali components from the concrete, while assuring adequate structural strength. In order to resolve the problems related to the mechanical strength of the structure, a two-layer concrete system is used. A concrete layer with continuous air gaps - that is, a porous concrete layer - acts as the top layer and a concrete base impermeable to the cement paste provides the bottom layer.

The plant varieties planted on this type of structure are members of the sedum or stonecrop family, selected for the high resistance to desiccation that is characteristic of these succulent plants.

(1) Panel Preparation

The concrete panel consists of a bottom layer that provides the base and a top layer of porous concrete with continuous air gaps.

1) Casting the Porous Concrete

After the concrete base (bottom layer) has been formed the porous concrete layer is placed on top before the concrete base has properly hardened. The bottom layer is produced by pouring concrete in the usual manner and the top layer of porous concrete is cast over its surface before the concrete has completely hardened.

2) Fillers

The soil which may be any of the generally used plant growing soils such as black or red soil, is sieved to provide the correct particle size distribution. Additions of vegetable fiber type soil-improving materials such peat moss or coconut moss, sieved for particle size sorting in the same manner, are then made in the range from 0% to 40% by volume and mixed with the soil. This basic mixture may then be modified by adding fertilizer and water-retaining (moisture-absorbing) components as required.

3) Types of Plants Used for Greening

An essential requirement is that the plant varieties preferred for this purpose are plants belonging to the Sedum family or plants such as the members of the hylotheplium, rhodiola and orostachys families taxonomically classed as belonging to the representative Sedum genus. The members of the sedum family are extremely hardy and capable of stable growth even when left to grow in the wild.

4. Comparative Evaluation

As an example, a two-layer concrete structure consisting of a 10cm top and 5cm bottom layer were formed to produce a panel with a 30% pore ratio. The air gaps were then filled with the growth base. The sedum plant used for the green coverage was the evergreen climber Live-Forever. The concrete structure had an incline of 90 degrees sloping southward. Observation of plant development showed that the plants presented normal growth for three months in the summer and drooping down to cover the entire wall surface. The plants withstood the wintered and growth was sustained for more than a year.

This demonstrates that the continuous air gaps required for plant growth can be assured with a porous concrete having a porosity of around 30% by volume and that the vegetation needed for the greening of concrete structure must be desiccation-resistant plants, preferably of the sedum family.