PLANNING GUIDE

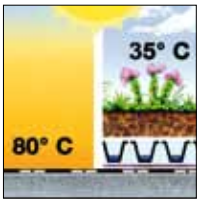
System Solutions for Sloped Green Roofs

Life on Roofs

Why Have a Green Roof?

Urban, construction and ecological advantages:

Extended Roof Life

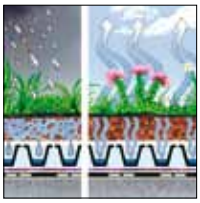


- Protects the roof membrane from UV exposure, heat cold and hail and mechanical damage.

New Habitat

- Encourages wild-life to remain within build-up areas.

Stormwater Management

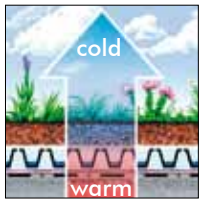


- Reduces immediate water run-off. The sewer pipes can be reduced in capacity.

Reduction of Dust and Smog Levels

- Enhances the micro-climate by cooling, filtering out dust and smog particles.

Improve Building Operations



- Thermal protection in both summer and winter and reduction of heating and cooling costs.

Noise Reduction

- Improves sound insulation.

Features

- In contrast to flat roofs where roof gardens are often installed, sloped roofs are usually equipped with low maintenance extensive green roofs.
- Shear forces are to be derived into stable eaves edgings and – if necessary – into additional shear barriers using load absorbing elements.
- Due to the faster water runoff on sloped roof areas the growing media layer needs to be increased.
- To prevent erosion on sloped roofs plants should be applied with a higher density; in case of a steep pitch precultivated vegetation mats are recommended.
- On sloped roofs the orientation of the roof area (North / South) might affect vegetation development.

Principles

ZinCo sloped green roofs are installed in accordance with current standards.

Our six principles at a glance:

- The System Build-up is tailored to suit each roof.
- The System Build-up ensures permanent drainage, even under load.
- The System Build-up provides for a good water/air balance.
- The System Build-up is adapted to suit the required type of vegetation.
- The System Build-up keeps maintenance and upkeep to a minimum.
- The System Build-up provides for a long green roof life.

All vegetation specific information is based on moderate continental climate. Please contact us for any other climatic condition.

More Options with ZinCo

→ Please see our Planning Guides :

- *"System Solutions for Intensive Green Roofs"*
- *"System Solutions for Extensive Green Roofs"*

for more information.

Enduring Success with Sloped Green Roofs – What Do we Need to Know?

When is a Green Roof Sloped?

While even flat roofs should have a pitch of at least 2 % the purposes of this brochure is one with a pitch of at least 2/12.

Upwards of this pitch, the green roof build-up differs from those that are used for flat roofs and low-sloped roofs.

The shear forces from the green roof build-up increases the steeper the roof pitch is. And needs to be diverted to a sufficiently stable counter support. The growing media layer also has to be protected from erosion. The choice of plants and their application must be compatible with the roof pitch and the level of exposure.

Additional Irrigation

Additional irrigation during dry periods guarantees an impressive appearance and extends the flowering season. Irrigation can be provided either by means of drip lines installed along the roof ridge or "over head" by means of a sprinkler or spray nozzle.

A Root Resistant Waterproofing is a Requirement

The waterproofing membrane should be root resistant, as it is very difficult to install additional root resistant sheets on sloped roofs.

It is important that the issue of the maintenance of the green roof is addressed right from the beginning. Skylights can be used to access the roof area. A sufficient number of anchor points should be planned for around the roof area, to which people can anchor themselves when carrying out maintenance and service works on the roof.

In the case of roof penetrations it is important to ensure that the waterproofing layer is drawn up to at least 4 in. above the upper edge of the growing media layer.

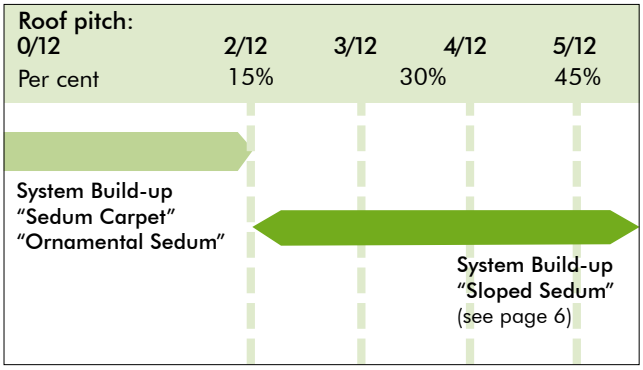
The use of solar energy is also possible on sloped green roofs. The issue is how each system can be installed without penetrating the waterproofing, e.g. by using the ZinCo Solar Base®.

This roof with a pitch of approx. 1/12 is drained using a gutter and does not yet require any special measures.

A shear barrier is placed just above the eaves on this monopitch roof, which is drained by means of an outer-lying gutter.

With this roof, which has a pitch of approx. 7/12, a shear barrier was installed within the roof area, in addition to the stable eaves.

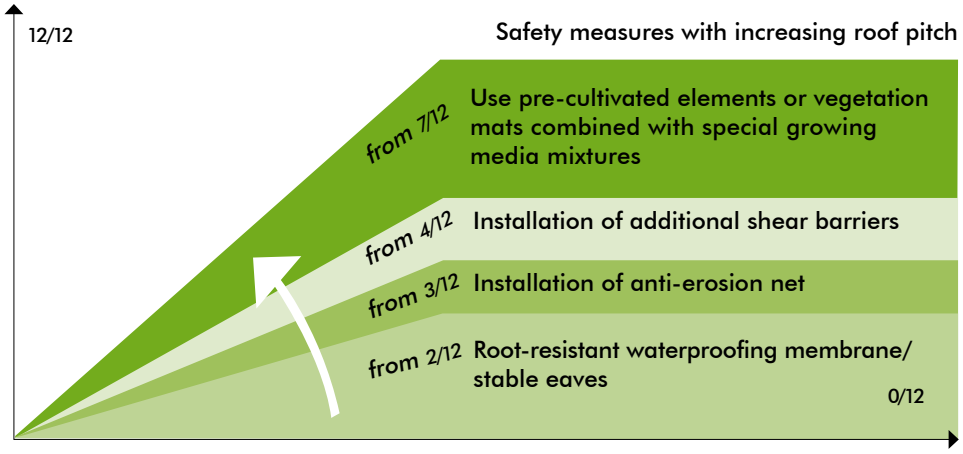
When dimensioning an eaves or shear barrier, the decisive factor is not only the water-saturated weight of the green roof build up, but also the estimated snow loads for the location.



Shear Forces

The diagram on the right indicates which measures are generally required for which roof pitch.

It is also important to check roofs with a slope smaller than 2/12, if measures have to be taken to prevent the roof layer package from slipping down. This may already be useful for roof slopes starting with 1/48.



System Build-up "Sloped Sedum" with Georaster®

The System Build-up "Sloped Sedum" based on the ZinCo Georaster® system, as presented here, is suitable for greening roof areas with a pitch of over 2/12. The Georaster® elements are approx. 21 in. x 21 in. in size, approx. 4 in. high and made of recycled polyethylene (HDPE). No tools are required to attach them to each other. The result is a stable and continuous unit.

An area on which these grid elements have been installed is safe to walk on and can be filled with growing media. Thanks to the low volume of the Georaster® elements themselves, a relatively large space remains for root development. The choice of plants must, of course, be suited to the extreme location of a sloped roof, where exposure to the sun can be extreme and rainwater flows off quicker than on a flat roof.

In order to avoid gaps in the vegetation that could also be the start of erosion, irrigation should be considered as an option, even though it may only be needed in critical times. With the System Build-up "Sloped Sedum" it is important to ensure that any occurring shear forces can be diverted to stable eaves and, if necessary, additional shear barriers.

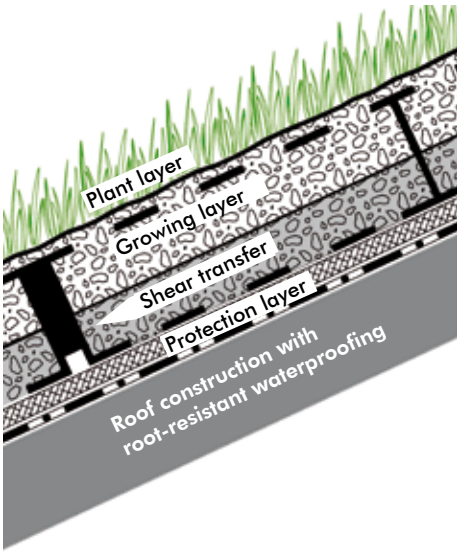
In addition to their use on sloped roofs, Georaster® elements can also be used as a reinforcement for gravel lawns, for creating pathways, when securing embankments etc.

Steps to Creating a Sloped Green Roof:

The roof area to be greened is sealed with rolls of waterproofing membrane that have been tested for their root-resistance (in line with FLL procedures.)

Once the area has been covered with the Protection Mat WSM 150, the Georaster® elements are installed, starting from the bottom up.

Depending on the roof pitch, growing media Zincoblend E or Zincoblend I is applied onto the roof until the Georaster® elements are filled and covered up to a total depth of about 4.25 in.



Plant Community "Sloped Sedum"*)

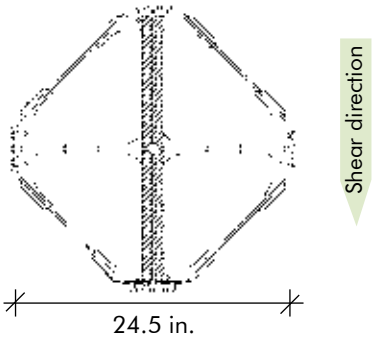
Growing Media "Zincoblend E or I",
Depth: ≈ 4.25 in. (≈ 110 mm)
< 4/12 Zincoblend E
> 4/12 Zincoblend I

Drainage Element Georaster®

Protection Mat WSM 150

Slope:	2/12-8/12
Height :	≈ 5 in.
Weight:	≈ 35 lbs/sq. ft.
Water retention capacity:	≈ 1.4lbs/sq. ft.

Georaster® element

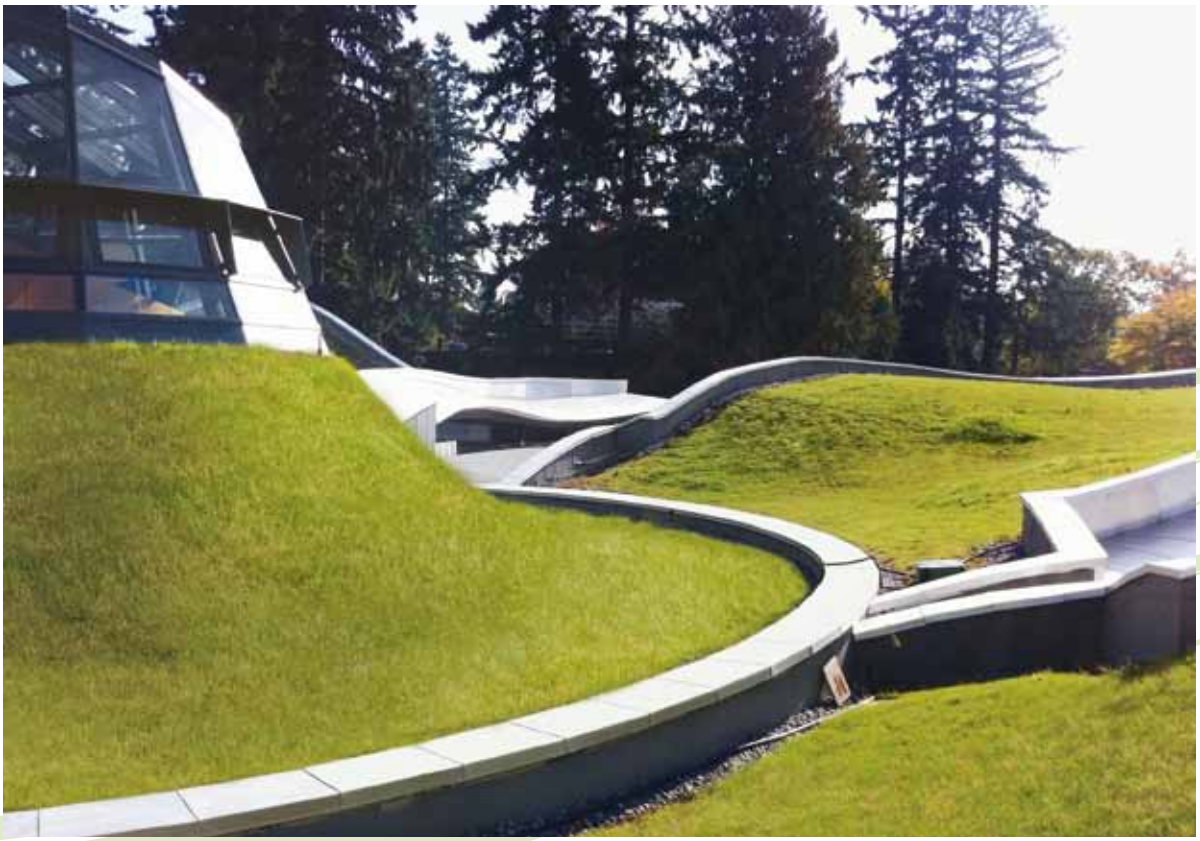


*) *Georaster® elements are generally planted with at least 1.5 plants /sq.ft.. Therefore, there are at least 2 plants in each field of the element. Additonals perennials for visual highlights as per the plant list "Sloped/Steep Sloped Green Roof" are possible. We recommend using pre-grown vegetation mats for roofs of approx. 7/12 and upwards.*

Finally, the roof is densely planted with various Sedum species and other perennials.

Even after only one vegetation period the plant coverage is largely complete. The roof area in this example is drained by means of an outer-lying gutter into which the three water spouts carry any excess water.

Green Roof Solutions for Sloped Roofs of a Different Kind



The curved shapes of an orchid native to British Columbia served as the template for the green roofs on the visitor centre at the Van Dusen Botanical Gardens in Vancouver, Canada. Grouped around the roof of the central atrium, which is designed as a truncated cone, and which also represents the pistil of the orchid, are other roof areas that resemble petals.

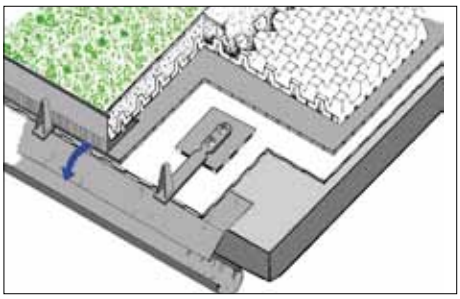
This concept was realised using System Build-ups "Sloped Sedum" with Georaster®.

Greening the very steep areas of the truncated cone with pitches of up to 12/12 was achieved by dividing those areas into segments with rings.

Technically Sound Details for Success with Your Sloped Roof

Roof Perimeter with Drainage into Outer-Lying Gutter

Very often with sloped green roofs, an outer-lying gutter is the drainage option of choice. With this option, the shear force created by the green roof build-up has to be transferred to the roof structure via an eaves profile with drainage slots.
This allows for excess rain water to drain away unobstructed.



Intensive Green Roof on Sloped Roofs – It's possible with System Technology

When the building complex "Australia Building" in Amsterdam, the Netherlands, was being renovated. The dreary courtyard and warehouse beneath were brought back to life with 600 sqft area. This was to include the green area with "portholes" protruding from the steep sloped areas. These portholes provide daylight for the rooms below.

The transition from the flat to the steep section was challenging from a green roofing point of view. On the flat part, the System Build-up "Roof Garden" with a growing media depth of approx. 8 in. was used. In order to apply the required shear-protected and growing media depth to the *10/12* steep sloped areas, Georaster® elements were installed in two staggered layers. Elastodrain® Strips were used as a base to protect the waterproofing membrane in the eaves area. Since completion, an irrigation system provides for the luscious greenery.

Roof Design with a Difference:
Even Material Variations have their own Charm

Unusual, but certainly with charm. A tiled/green roof on a private residence.

This semi-detached house provides a contrast between different types of design. Wooden and rendered facade, tiled and green roof.

Sometimes it is a matter of structural design, as can be seen here (extreme pitch in the lower roof area), that leads to two different "coverings" being used on the same building.

Green Roofs on Barrel Roofs – the Basics

The System Build-up "Sloped Sedum" can also be used for barrel roofs.
There is no standard solution for barrel roofs. However, solutions specific to your building can be worked out in conjunction with the ZinCo Technical Department.

As gravel edge strips cannot be used for roofs with an extreme pitch, grass pavers ensure a solid and location-stable option for eaves drainage.

In the picture on the right, the System Build-up "Sloped Sedum" with Georaster® elements is installed in the steep, lower area. The elements distribute the shear forces into smaller portions and help to keep the erosion to a minimum.

The transition to the area with lower pitch is possible thanks to a project-specific solution: The shear forces of the upper area are diverted into the roof structure by means of an Eaves Profile serving as a shear barrier.

Particularly Significant for Sloped Green Roofs: the Correct Choice of Plants

In order to prevent erosion, the vegetation layer on a sloped roof should be permanently covered. As these roof areas are generally visible, a sloped green roof should of course be visually very appealing. However, a sloped roof is different in many ways to a flat roof: water runs off more quickly and is not as easy to retain. In the case of a steep pitch and an orientation to the sun, these differences are particularly accentuated. For structural reasons it is often not possible to increase the depth of the growing media. Without additional irrigation, therefore, the choice of plants is considerably limited.

The type of vegetation that will survive on sloped roofs without additional irrigation can be seen in these three photos. This green roof was build out in 1986. The turf rolls installed initially on the north-facing side failed entirely after a short period of time, while the Sedum-herb vegetation on the south-facing side (plant community "Ornamental Sedum") also took over the north-facing side.

Grass on the Roof

As mentioned previously, a lawn can be established permanently on sloped roofs. However, it is important to take into consideration that the lawn has to be mowed regularly and that the cut grass has to be brought down from the roof. With a low build-up depth, the water supply must be ensured by means of a perfectly functioning irrigation system.

An alternative to a conventional lawn is drought-resistant grass vegetation. The result is a roof with "wild meadow character" in which a variety of species will be maintained when mowed once a year.

Plant Suggestion "Sloped Sedum"

Ground covers	Recommended proportion
Sedum album in varieties	approx. 0 - 10 %
Sedum floriferum 'Weihenstephaner Gold'	approx. 30 - 40 %
Sedum hybridum 'Immergrünchen'	approx. 15 - 20 %
Sedum kamtschaticum	approx. 15 - 20 %
Sedum spurium 'varieies'	approx. 15 - 20 %
Small group accent plants	
Plant list 'Sloped Sedum'	in addition to the above 04. pcs/sq. ft.
Plant density recommondation (incl. small group accents plants)	up to 15°: at least 20 pcs/m² up to 20°: at least 24 pcs/m² up to 25°: at least 28 pcs/m² up to 30°: at least 34 pcs/m²

Choice of Plants

Plug plants from the plant community "Sloped Sedum" can be used on sloped roofs. Sedum is generally the main type of vegetation used while the other perennials on a pitch of approx. 4/12 offer additional flowering, above all in the shady and less exposed areas. Generally speaking, they should only be used occasionally in groups of 3 or 5 (or maximum 7). Upwards of a pitch of **5/12**, the perennial "proportion" should be reduced, as Sedum is more capable of thriving with a low water supply and ensuring protection against erosion.

It is best to use only Sedum for green roofs with a pitch of **7/12** and upwards. It is worth noting that the surface for a single Sedum species should generally be limited to 21-33 sqft. The above-mentioned Sedum species will provide for stable vegetation with good ground coverage if the recommended proportions are adhered to.

Planting

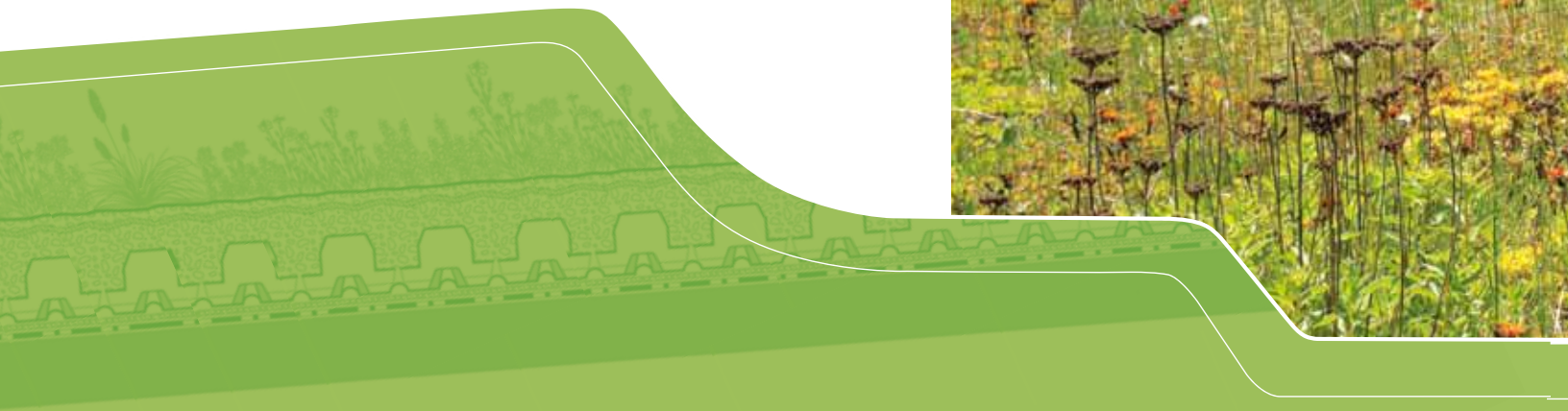
- Water plants prior to planting
- Lay out Accents randomly in groups of 3, 5, or 7 and Ground covers to infill spaces in between Accents on well leveled growing media surfaces. 50 plants ensure a blanket vegetation of one species fo about 33 sq. ft. Lay out only as a many plants as can be planted within 2-3 hours, esp. in hot weather. Plant plants well and press into the growing media.

System Technology – Provides for a Permanent and Perfect Green Roof!

This Planning Guide aims to give you a general overview of the technology involved in the various sloped green roof options.

Our technical experts will be pleased to advise you on specific solutions for your own individual building projects: from the planning phase right through creating your specification texts.

Challenge us!



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