

Roof of MSU's Plant and Soil Science Building becomes green roof research site

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Background

It is no secret that as our forests and agricultural lands are replaced with impervious surfaces due to urban development that the necessity to recover green space is becoming increasingly critical for the health of our environment as well as our well-being. Utilization of vegetation on rooftops helps mitigate this problem as green roofs provide numerous ecological and economic benefits. In addition to their aesthetic qualities, green roofs provide insulation for buildings, reduce the amount of runoff entering municipal storm water management systems; and increase the life span of a typical roof by protecting the various roof components from damaging UV rays, extreme temperatures and rapid temperature fluctuations.

The green roof research program at MSU was initiated during 2000 in collaboration with Ford Motor Company in an effort to advise them on the installation of a 450,000 square feet green roof that was recently installed on a new assembly plant in Dearborn. The Ford roof is currently the largest green roof in the world. Since the conception of this collaboration, we have continued research of potential plant species, propagation and establishment methods, substrate composition, water and nutrient requirements, and water quality and quantity of runoff. Numerous experiments have been completed and others are currently being conducted in the Plant Science Greenhouses and on 48 simulation roof platforms located at the Horticulture Teaching and Research Center at MSU. The new roof planting on the Plant and Soil Sciences Building (PSSB) at MSU will augment our existing green roof research efforts.

Objectives of PSSB green roof

1. Evaluate influence of vegetation on temperatures at the roof membrane, heat flux through the roof and how this influences energy consumption.
2. Evaluate mixed plant communities composition and succession over time.
3. Raise public awareness regarding the benefits of green roofs.
4. Help establish MSU as a leader in environmental stewardship.

Roof installation and instrumentation

On May 21, 2004, an extensive green roof was installed over a portion (3500 ft²) of the headhouse on the Plant and Soil Sciences Building (PSSB). Prevegetated sedum mats (XeroFlor America, LLC, Lansing, MI) consisting of a substrate carrier, substrate and ten species of sedum were grown in an agricultural field, harvested and stacked on pallets, transported to the building and then rolled out like sod on the roof. Prior to laying vegetation, the existing gravel roof ballast was removed and a root barrier membrane, drainage layer, filter fabric and water retention fabric were applied. Structural reinforcement of the building was not necessary, as the vegetation has a saturated weight of less than eight pounds per square foot, which is roughly equivalent to the gravel ballast that was previously in place. Plant selection was limited on the PSSB because of building structure weight restrictions that limit substrate depth.

The roof now has a section of vegetation in addition to the part of the roof that remained as a conventional roof covered with the gravel ballast. Thus, we have two experimental roof sections where we are monitoring substrate moisture, heat flux and temperatures at various locations in the roof profile. On the green side of the roof, thermocouples were placed inside the building, at the top of the roof membrane, above the insulation, between the water retention mat layers, at the top of the growing substrate beneath the plant canopy and one meter above the roof. On the conventional roof side thermocouples were placed inside the building, at the top of the roof membrane, above the insulation under the gravel ballast, on top of the gravel and one meter above the roof. Sensors are replicated three times at every roof profile location in the ballasted and vegetated roof sections for a total of 33 thermocouples. In addition, heat flux sensors were installed at the roof membrane on both sides to measure heat entering or exiting the building through the roof. Ambient temperature, relative humidity, wind speed and direction, irradiance levels and precipitation are being recorded by a weather station that was installed on the roof. Data from all sensors are being collected every five minutes, 24 hours a day using a Campbell Scientific CR10X datalogger with peripheral multiplexers, switch closure modules and storage module.

Impacts

One advantage of installing a research/demonstration green roof on the PSSB is the building's location in the center of the MSU Horticulture Gardens. Although the roof is not visible from ground level, it is visible from the main building, a web-cam will be installed above the roof for remote viewing, and model green roofs will be constructed at ground level. Over 200,000 people visited the MSU Horticulture Gardens during 2003 and this number is projected to reach 500,000 within the next five years. The MSU Horticulture Gardens are one of the leading tourist attractions in Michigan and are a unique resource for MSU. The number of garden visitors coupled with our research and promotional efforts surrounding this roof will help raise public awareness regarding the benefits of green roofs and help establish MSU as a leader in environmental stewardship.

The roof on the PSSB will also serve as effective on-campus laboratory. In cooperation with heat flow experts in mechanical engineering, data will be analyzed to develop a model for energy conservation. New plant species will be tested for rate of establishment, survival and persistence, and we will evaluate mixed plant community composition and succession over time. We also have the potential to obtain quantifiable data comparing storm water runoff quantity and quality. Furthermore, green roofs represent an entirely new market for landscape designers/architects, nursery operations, and landscape contractors; and the potential market includes most existing and all future roofs in the country.

For more information on green roofs, visit our website at: www.hrt.msu.edu/greenroof/



View of the green roof from a fifth floor window of the Plant and Soil Sciences Building



PSSB green roof during October 2004



Installation of sedum 'sod' on roof of PSSB in May 2004



A green roof can be applied to smaller buildings as well.