

GROWERTALKS

Features

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The Engineering Behind Rooftop Greenhouses

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Twenty years ago, none of us would ever have envisioned dozens of greenhouses on the roofs of random buildings in cities like New York, Chicago and San Francisco. And we continue to see them popping up in many urban areas around the United States and Canada.

Colorado-based Nexus Greenhouse Systems has been erecting growing structures for ornamentals growers, garden center retailers and university researchers for the past 50 years. Although Nexus has been building rooftop greenhouses for decades, the last five to 10 years has really shown an uptick in interest, said Jeff Warschauer, VP of sales for Nexus.



Pictured: The greenhouse on top of the Arbor House apartment building in the Bronx, New York.

“Urban agriculture is here to stay,” he said. “Interest is going to get stronger and stronger as we take on more projects. The amount of phone calls from people interested in rooftop greenhouses that Nexus receives is phenomenal.”

As we hear about more and more rooftop greenhouses adding to the skyline of many cities, we were wondering about the differences and challenges that come with building these unique growing structures versus greenhouses built on the ground.

The building: Can it even hold a greenhouse?

This is the first thing that Jeff and his team do before they even give the potential customer a quote because if

the building isn't sound, then it's pointless to even move to the next step. Nexus engineers, along with the building's engineer, work together to evaluate the roof from the standpoint of the overall condition and, most importantly, the roof's ability to support the greenhouse and all the related equipment.

"Sometimes the greenhouse owner wants to build on a certain building, but the building may need to have a lot of extra support framing to hold the weight, as well as the attaching columns of the structure," said Jeff. "But are you willing to spend the extra money to do that? Or do you go look for another building that is more structurally sound and designed to better fit with the greenhouse?"

A majority of the time, the buildings aren't owned by the growing operation, so you have to find a landlord that's open to having a greenhouse built on the roof of their building. It's not always easy, but Jeff said that more and more owners are expressing interest. And as the local food movement becomes more popular and gets more press, landlords and business owners are actually approaching growing operations directly to see if they would be interested in putting a greenhouse on their roof.

Another aspect to consider is roof access. Many city buildings only have a hatch door with a narrow set of stairs or ladder to get to the top, so a regular door, staircase and/or elevator (maybe multiple ones) need to be included as part of the project as well.

Permits/zoning/other legal stuff

This is where it gets a little hairy. Jeff said that, with regard to pricing, a rooftop greenhouse is comparable to a ground-based one. But it's the other details that will cost the most money—like bringing up the gas, electric, water, permitting and the "professional fees" from the engineers, architects, city building inspectors, etc. needed to get your project going. Those fees alone can be 10% to 15% of the cost of the structure, so for, say, a \$1 million project, you'll be paying about \$90,000 to \$100,000 in fees.

And, as you would expect, the time it takes to get building permits in a big city takes longer than if you were building a greenhouse in rural America. Jeff said it could take over a year to get all of the proper permits and zoning issues resolved with the city.

Attaching the greenhouse

Jeff said that Nexus often suggests to clients that they build a wider span greenhouse. That way, there are fewer posts to attach to the roofs.

"Most ground-based greenhouses are installed into caisson-type foundations. When you're building on a roof, the greenhouse typically uses special plates on the columns to attach to the roof," explained Jeff. "As an example, on one roof we might have eight 21-ft. wide greenhouses, 200 ft. long or we could have four 42-ft. greenhouses, 200 ft. long. That would mean about half the posts."

Nexus engineers will help design the special connection for the posts and determine where each should be attached based on the building's design that supports the roof. This, in turn, will dictate how wide the greenhouse will be based on where the posts are positioned.

Building it

First, ground-based greenhouses will normally have a secure spot near the build site where you can store and stage all of the materials during delivery and installation, taking what you need as the project progresses. But on a roof in a congested city, you have room for the structure and that's it. Most of the time, you can't leave the building materials on the street or put them on the roof next door. In some cases, streets may have to be closed during construction. This can be quite costly to do and, in most cases, requires a permit.

So what Nexus does is gather all of the materials in one of their warehouses and ships the materials one load at a time as needed. They also ask all of the different vendors that provide the irrigation systems, benching, climate controls, machinery, etc. to ship everything to Nexus and then they'll make sure it gets to the job site as needed. This helps clients and vendors from having to figure out where to store their equipment or the customer from having to find multiple places to keep items.

Another thing needed is a crane. You can't very well lug polycarbonate sheets or steel trusses up flights of stairs or fit them in a small freight elevator, so you need something to bring it up to the roof for you and this costs money and takes a lot of coordination. Not only do you need to make sure the crane is there and ready to go, but, as Jeff explained, he tries to have the crane's work done by 2:00 or 3:00 p.m. because most cities don't want a crane chugging along city streets during rush hour.

Another possibility is a helicopter. Jeff is working on a 45-story building project right now and the only way to get the large material to the rooftop is with a helicopter. This is even more costly since not all helicopter pilots are willing to take on such a project.

You also have to inform the building tenants and neighbors around the area about the project weeks in advance, especially if their parking options will be limited for a few days.

"One major factor when building on rooftops is to figure out how to get gas, electric and good, quality water up to the roof. If you cannot get utilities up there, it's not worth even building it because alternative utility options are extremely costly," said Jeff, so you have to make sure the utilities are available and affordable.

And where do you put the water? Most buildings have roof drains or openings where the greenhouse roof rainwater can drain so water doesn't "pond" on the roof. Many times, you have to adjust downspout locations to be close or exactly where the roof drain connections will be.

There's a lot of coordination between the building owner, the greenhouse operator/owner and the local building department. As you can see, these projects are not for the grower who's not adventuresome. You have to be willing to deal with many roadblocks, higher costs and things you've never dealt with before. You want to make sure that the greenhouse manufacturer that you use has done projects like this and that they're not "learning" during your project.

The structure itself

"Rooftop greenhouses are similar to ground-based ones with a few exceptions—special widths are requested with wider clear spans of 45 ft., 47 ft. or even wider," Jeff said. "The fewer the columns, the fewer roof penetrations and that's a good thing from several perspectives. Also, wide houses have larger attics and that means a cooler and drier greenhouse.

“Sometimes, heights may become a building/zoning code issue. To reduce the peak height that comes with a single peak, say a 48-ft. width, we might offer two peaks that are 24 ft. each, on a clear span of 48 ft., and by having two peaks, we reduce the structure’s roof heights. As an example: 48-ft. wide single roof height would be 24 ft. at the peak when using a Vail Atrium greenhouse with 12-ft. sidewalls. The twin 24-ft. peak Nexus Dual Atrium with 12-ft. sidewalls would be 18 ft. at the peak.”

You also have to take more consideration of the possible weather conditions, like wind and snow. With a typical greenhouse, you can just brush the snow off and let it fall down the sides next to the structure. But you can’t do that in a congested urban neighborhood or the neighbors may not like you very much.

“Who clears snow off the roof in winter in New York City? What do you do with it? For sure you just can’t toss it on the cars or folks below,” said Jeff.

Another requirement is that Nexus places “snow rakes” at the bottom of the roof slopes to prevent a whole avalanche of snow from sliding off the roof and landing on someone on the street. The rakes break up the snow so that it falls down lightly and in broken-up pieces.

Another consideration when building on a rooftop is how close to the edge of the roof the greenhouse should be. Nexus prefers to have a walk area around the greenhouse, but many growers don’t want to give up that valuable growing space, so they wish to build right on the parapet wall. If your greenhouse is being built on the parapet wall and you have walkways and/or parking below, then you need expensive “sidewalk protection” during construction and brought back when it’s time to do maintenance on the greenhouse roof or when doing something like changing the covering. This is very expensive to do.

Most of the time, wind is more of a concern and is closely scrutinized by the engineers and building inspectors. Jeff said in many cases, “uplift” is more critical or, in some cases, more difficult than how much the overall load is at the base of the greenhouse—meaning you want to ensure your greenhouse doesn’t get pushed over or even lifted off of the roof during really windy days.

“As with any greenhouse, you have to think about when and how you’re going to replace the walls and roof. For example, if you chose a double poly roof for the house, you may have to rent expensive lifts and cranes to replace it every four years—and that’s if ice and snow don’t do any damage beforehand,” said Jeff, so most rooftop greenhouses are built using polycarbonate or glass.

And along that same vein in trying to be a good neighbor, Jeff said that business owners have to consider how many lights the greenhouse will be using, especially if it’s located in a residential area. “No one wants purple LEDs or bright HIDs shining from across the street right into their bedroom window at night. In these cases, we would want to provide a blackout curtain system for the sides, ends, and sometimes, the roofs,” said Jeff, because most codes have restrictions with regards to light pollution.

Lastly, don’t even consider building a commercial rooftop greenhouse without hiring professionals. This includes design architects and structural and mechanical engineers that are familiar with the roof and building that you’re considering for the greenhouse.

“Nexus professional engineers are licensed in most states. We provide sealed plans and work with the local building engineers to assist with the design, as well as the permitting process,” said Jeff.

Some of the implied thinking out there—especially among the non-industry people—is that slapping a greenhouse on a roof is easy. But as you can see, it takes an enormous amount of time, capital, coordination and patience in order to complete these projects. It’s not something to take lightly; it’s a commitment from beginning to end.

And not just for the growing operation, but for companies like Nexus, too. With the time it takes to complete a rooftop greenhouse, you could probably build two ground-based ones. Originally these projects appeared to be one-of-a-kind, but in recent years, cities, grocery chains, apartment buildings, and universities have discovered the value of using their rooftops. Nexus has become the expert on what it takes to put a greenhouse up in the city skies.

“We try to educate people about the development of a rooftop project,” said Jeff. “We lend an aspect that’s above and beyond just selling them a greenhouse. You wouldn’t consider some of the things you deal with as problems at a typical grower’s greenhouse. Those customers are knowledgeable and may have built greenhouses before. The rooftop customer doesn’t know as much about the industry, growing and the latest technology. That makes it our team’s job to partner with them and to be the expert rooftop company.

“Every project is different and challenging in so many ways each project brings about a change in the local community and our world. It’s an exciting time to be in the greenhouse business.” **GT**