

TOWER OF STRENGTH

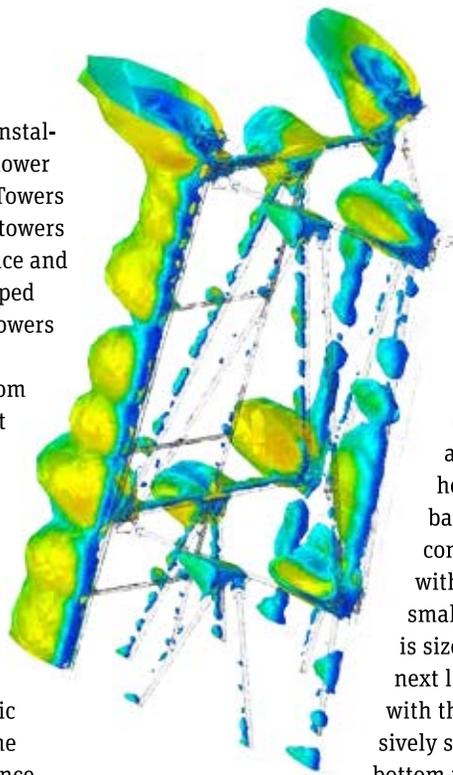
Brazil's vast interior areas are so sparsely settled that conventional fiber optic cabling is often not economical. Wireless internet service providers (WISPs) are racing to erect towers to provide internet access to rural residents. Jet Towers used ANSYS AIM simulation software to design a line of truss tower modules that makes it possible for the company to build and install wireless towers in only one week, one-fifth the time required by conventional methods.

By **Ricardo Damian**,
Director of Engineering,
Jet Towers,
Santiago, Brazil



While optical fiber is the primary method of providing internet access to Brazilian city dwellers, it is not economical in most of the country's sparsely populated rural areas. Two decades after internet service first became available in Brazil, only 22 percent of residents of rural areas had access to broadband internet. A number of Brazilian WISPs are increasing this number by providing tower-mounted Wi-Fi to rural areas. WISPs that are competing to provide internet service to underserved areas face the challenge of quickly building towers and putting them into operation so they can sign up customers before competitors enter the market. In addition, cellular companies and radio stations are continuing to build out infrastructure, which requires even more wireless towers.

Design, construction, shipment and installation of a typical 45-meter wireless tower normally takes about five weeks. Jet Towers has a better way — a modular line of towers whose components are built in advance and kept in inventory so they can be shipped and assembled in about a week. Jet Towers design engineers used ANSYS AIM to optimize the design of its modules from a fluid flow and structural standpoint from within a single immersive user environment. Engineers then embedded the intelligence behind these designs in a spreadsheet so they can be configured by nontechnical staff to provide customers with a design and quote in a matter of minutes. Jet Towers engineers have also used ANSYS HFSS electromagnetic simulation to evaluate the effect of the tower structure on antenna performance.



▲ CFD simulation of forces exerted by wind on the tower structure

WIRELESS TOWER DESIGN CHALLENGES

The main variables in designing wireless towers are the height of the tower and the size of the antennas. The height of the tower plays a key role in determining its range, and the size of the antennas determines how strong the tower needs to be to withstand wind loading. Traditionally, WISPs provide tower companies with their requirements and engineers use handbook equations or simple simulation software to design the tower and determine its manufacturing cost. If the WISP places an order, the tower company cuts steel beams and welds or bolts them together, delivers the tower to the site and erects it. The entire process takes about five weeks.

When the founders of Jet Towers started the company less than a year ago, they set out to help WISPs erect towers faster so they could beat their competitors to market. The founders decided to pre-engineer a series of standard six-meter-high modules that could be combined to produce any tower within a wide range of heights and antenna sizes. The basic idea is that the modules are constructed as triangular trusses, with a triangular base and a slightly smaller triangular top. Each module is sized to connect at its base with the next larger module and at its crown with the next smaller module. Progressively smaller modules are used from bottom to top because each module has less load to carry than the one underneath it.

Antenna size affects the structure because the projected area of an antenna's profile — the sum of its profile minus shadow effects — determines the amount of force applied to the structure by the wind. The modules can be used to design towers for different sized antennas by making the components at the base of the tower larger or smaller, which in turn automatically increases or decreases the size of each subsequent module moving up the tower. The height of the tower is determined by the number of modules used to construct it.

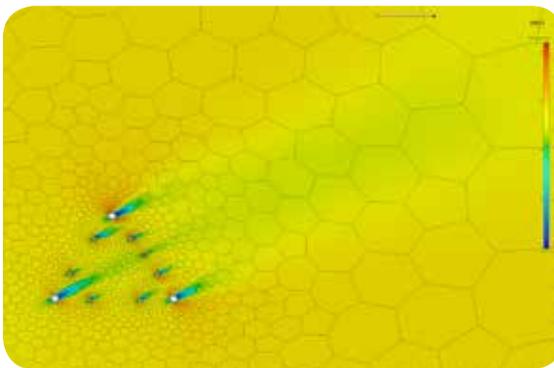


Jet Towers Uses ANSYS AIM
[ansys.com/jet-towers](https://www.ansys.com/jet-towers)

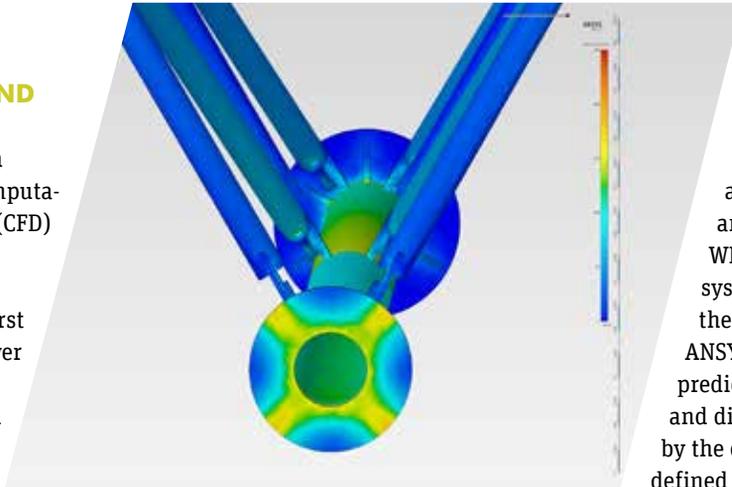
“Jet Towers can simulate all aspects of wireless tower design by applying the ANSYS AIM easy-to-use graphical interface, eliminating the need for analytical specialists.”

DETERMINING WIND LOADING

Jet Tower’s only design engineer used AIM computational fluid dynamics (CFD) to determine the load generated by different tower structures. He first imported the truss tower structure from the 3-D CAD system, generated its inverse geometry to create the fluid domain, bounded the fluid domain by a large cylinder and automatically meshed the space. One wall of the cylinder was defined as an opening boundary condition with flow velocity representing the maximum wind that Brazilian towers must be designed to withstand. The engineer performed a mesh-independence study to determine how fine a mesh was required and how many prismatic layers were needed at the boundary layer. He compared the overall force value over the structure from the CFD analysis with the calculated force from the simple analytical formula in the Excel® spreadsheet. Then, he calibrated the beam’s drag coefficients and projected area assumptions.



▲ FEA simulation used to evaluate beam profiles and bracing types



▲ FEA used to compare connection methods in truss tower modules

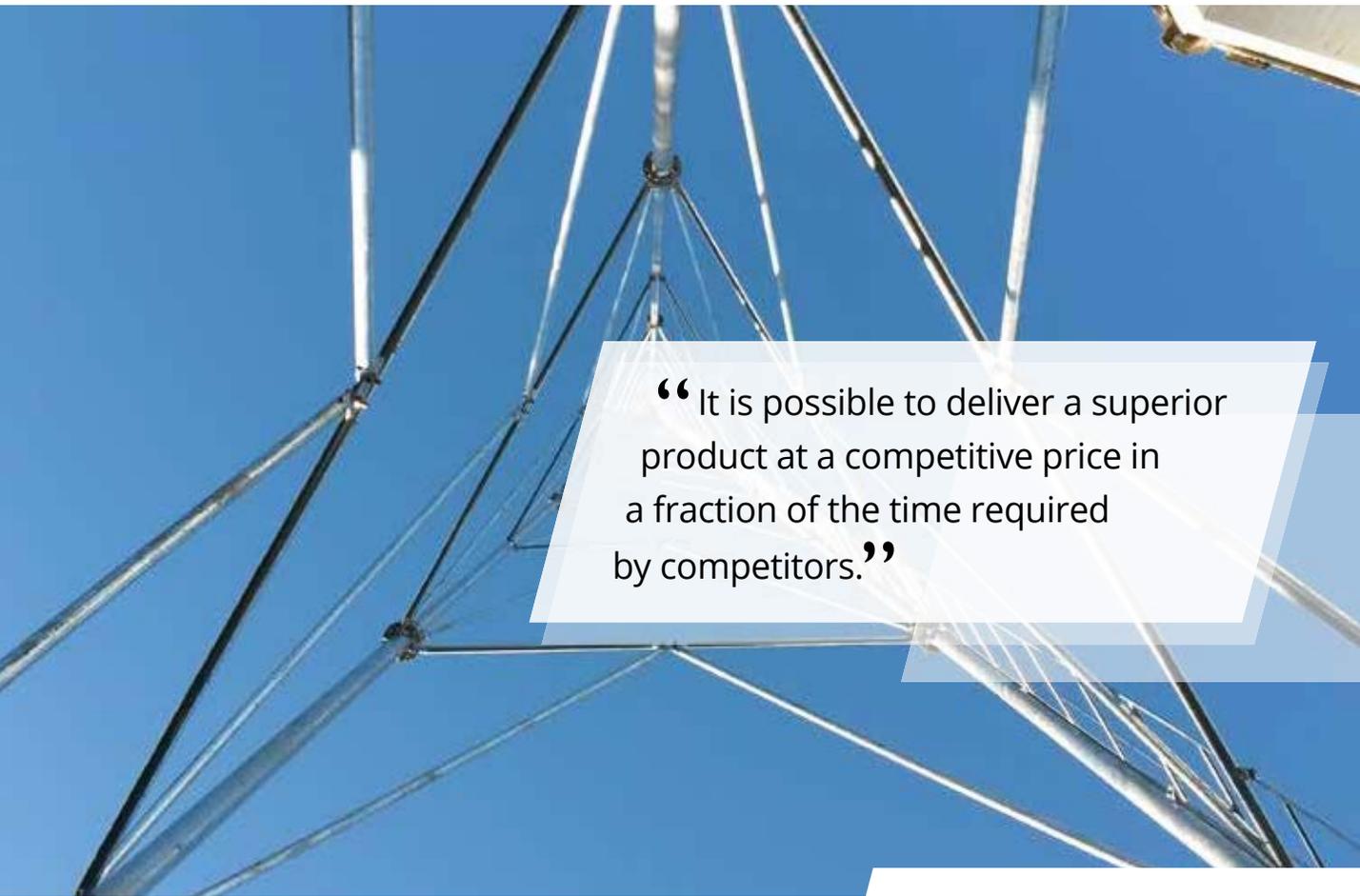
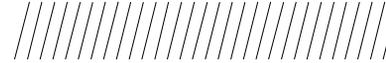
Next, the engineer defined the geometry of several additional common antennas used by WISPs in their CAD system. He opened the geometry in ANSYS AIM, used CFD to predict the wind loading, and divided the loading by the drag coefficient defined earlier to determine the projected area of the antenna. The engineer simulated the common antennas

used by most WISPs and used the drag coefficient to estimate loads for other antennas based on their projected areas.

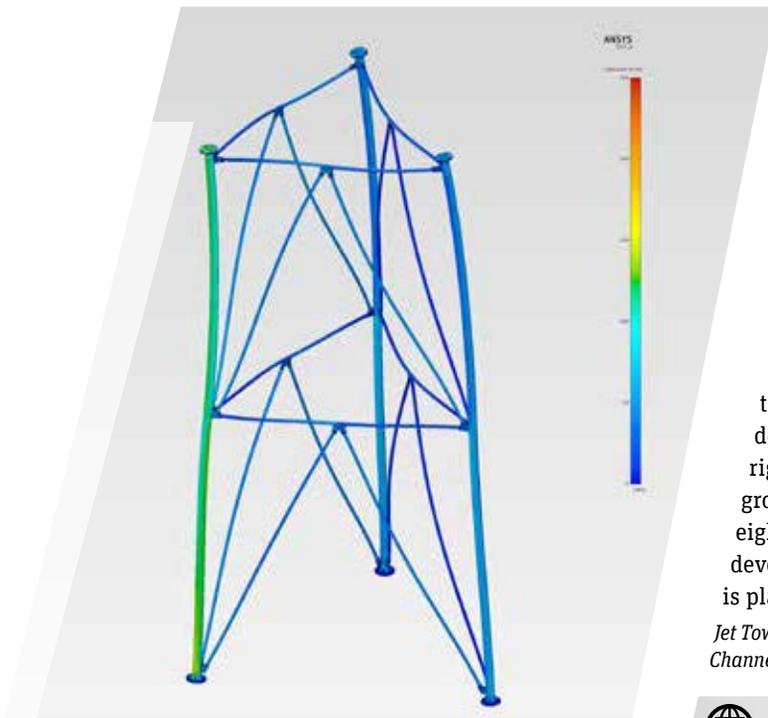
OPTIMIZING TRUSS TOWER DESIGN

The next step was using structural analysis to design modules that support the required loads with an adequate margin of safety, while keeping costs to a minimum. The engineer modeled the trusses using circular, rectangular, and L-, C- and V-shaped profiles, and then tried filling the enclosed profiles with concrete. He evaluated a wide variety of different connection methods, such as welding and bolting, and looked at different flanges.

The engineer manually simulated a wide range of different design alternatives and designed more than 20 modules to optimize the total installed cost of the tower, including materials, manufacturing expenses, freight, foundation and installation. Then he embedded the designs into a computer application so sales representatives and other team members having no engineering experience can simply enter key parameters (tower height, antenna size) into the spreadsheet. The spreadsheet then determines exactly which modules need to be combined to build the right tower for the application. The spreadsheet also determines the cost of the tower. Jet Towers keeps all of the different



“It is possible to deliver a superior product at a competitive price in a fraction of the time required by competitors.”



modules in stock so that the company can build and install a tower one week from receiving an order.

With ANSYS AIM, Jet Towers can simulate all aspects of wireless tower design in an easy-to-use graphical interface that guides engineers through the complete multiphysics workflow, eliminating the need for analytical specialists. Embedding the simulation results in a line of modular towers makes it possible to deliver a superior product at a competitive price in a fraction of the time required by its competitors. Shorter delivery time is what WISPs are looking for right now, so Jet Towers is experiencing rapid growth. The company built 35 towers in its first eight months of operation. Jet Towers is also developing several other products; simulation is playing a key role in their design as well. 

Jet Towers is supported by ESSS, an ANSYS Elite Channel Partner.



ANSYS AIM: Try it Now
[ansys.com/tryAIM](https://www.ansys.com/tryAIM)