Engineering behind heavy-duty single-point monopole platform mount and mount-to-tower interaction analysis

Jyoti Ojha, P.E., CommScope Principal Structural Engineer

Introduction

As mobile networks accelerate their 5G planning and deployment, the inability to support more RF equipment becomes a serious challenge for site architects, structural engineers and mobile networks operators (MNOs). This issue becomes particularly acute at sites involving sectorized monopoles that typically use a single point of attachment for RF equipment mounts and platforms.

With the 5G revolution evolving, demand is increasing for heavy-duty mounts that can support today's higher-load radio-integrated antennas. This white paper highlights the engineering and design of CommScope's new Atlas monopole platform mount.

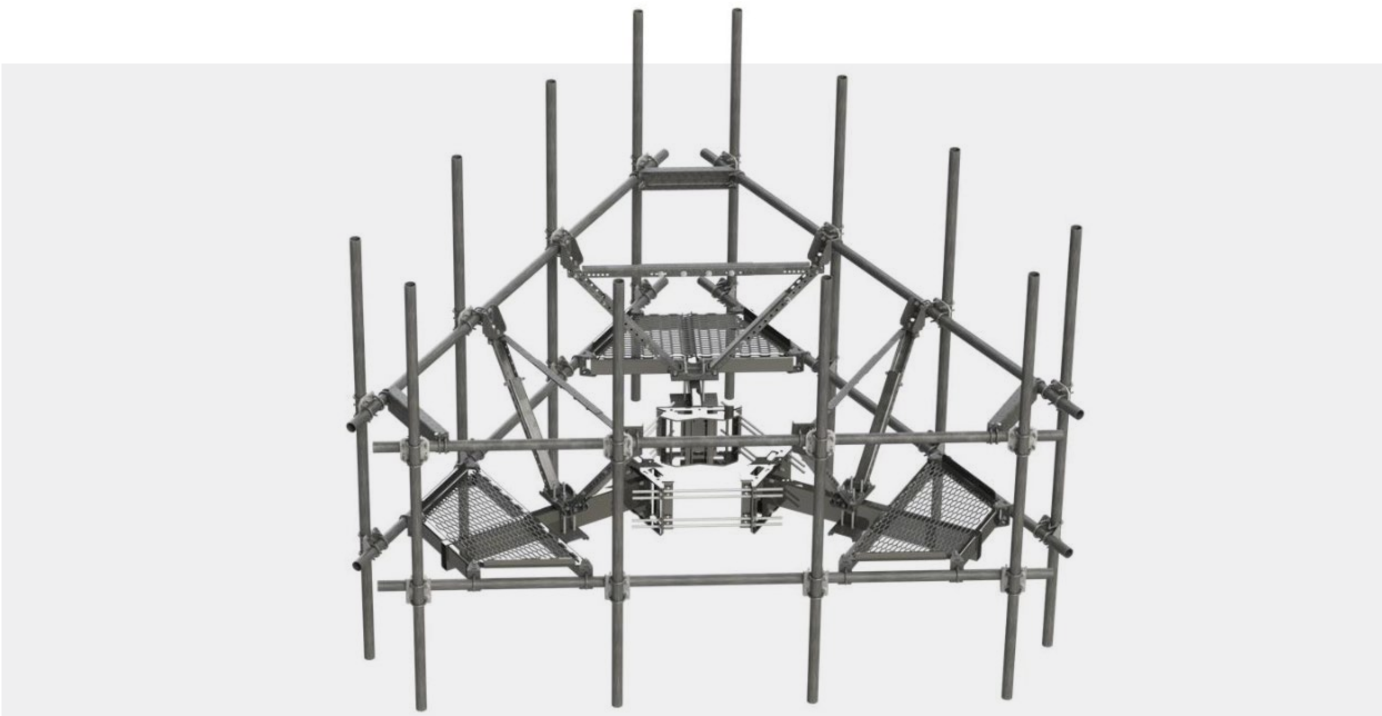

Figure 1: Atlas monopole platform mount

Design description

The Atlas monopole platform mount solution was developed following extensive research into the industry requirements for a high-load capacity monopole platform with simplified construction and verifiable compliance with the TIA-5053 standard.

The design uses deep rectangular hollow standoff tubes. This type of hollow structural section (HSS) standoff tube eliminates the need for a welded truss-type standoff system and enables the use of commercially available software, such as RISA-3D, for fast and simple analysis.

Analysis process

Commercial software, RISA-3D, was used for concept verification and validation of the overall structural integrity of the mount. Finite element analysis (FEA) was used to capture the physical characteristics for accurate load capabilities of the collars and mount-to-tower interaction analysis. The CommScope design team began by using SolidWorks to build a full 3D model consisting of the platform, support pipes and collar-mount components. These components were then transferred to ANSYS, the FEA simulation software, for analysis.

Design process and FEA validation

One of the limiting factors with the mounting of tri-sector frames is their vertical load capacity. This is especially true for frames that attach to the monopole via a single-point ring-mount collar. To increase the load capacity of the frame, OEMs can support the frame by adding standoff arms to create a truss-like structure. However, this may require significant welding or produce significant waste material, especially if the stand-off arm is cut out of a solid sheet or plate. Other designs consist of gussets—one on each side of the stand-off arms—which can increase manufacturing time and cost and result in a cavity where water can pool.

During the pre-design phase, the CommScope team identified the need to develop a mounting frame that would allow for easy and efficient fabrication during installation while reducing the manufacturing costs. Based on our research and evaluation, we designed a high-capacity collar mount that can accommodate the increased loads from a deep hollow rectangular tube stand-off platform and support greater equipment loads. FEA validation was conducted to finalize the required depth of the HSS tubing in conjunction with the new high-capacity ring-mount collar.

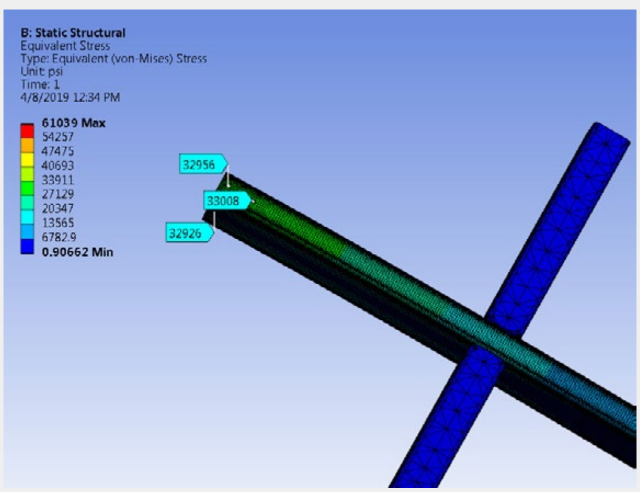

Figure 2: FEA validation of required standoff arm depth

Another feature of the mounting structure is the uniquely designed pivot brackets that replace the traditional clip angles generally made from bent steel plates. The traditional clip angles connect the triangle-base frame to the front horizontal members. The lateral wind forces acting in these horizontal face members may generate a bending moment along the weak axis of the clip angles. The new pivot bracket uses a dual flange with ample depth to compensate for the stress caused by high bending moments at the weak axis. This redesign was motivated, in l arge part, by the industry's move toward a more granular analysis methodology.

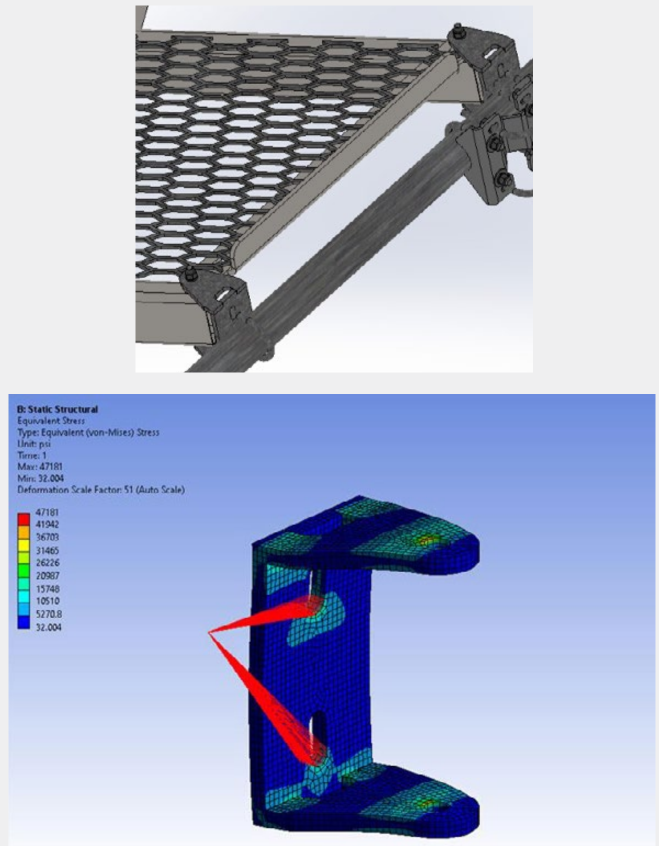

Figure 3: Rendered view and FEA validation of pivot bracket

With the frame members designed and their performance simulated, the team focused on the critical connection between the mounting collar and monopole. The first challenge was how to support the deeper stand-off arm. Multiple simulations indicated that using a traditional ring mount with two threaded rods would not support the increased new stand-off loads. The answer was to design the high-capacity collar-ring mount with two double-threaded rods located at the top and bottom of the collar mount. The depth of the collar base members was selected to maximize the loading.

Next, the focus turned to the mount-to-monopole connection. The team considered multiple designs—such as rounded members, double-angled members and flat-plate members—before finalizing the best need for the collar mount.

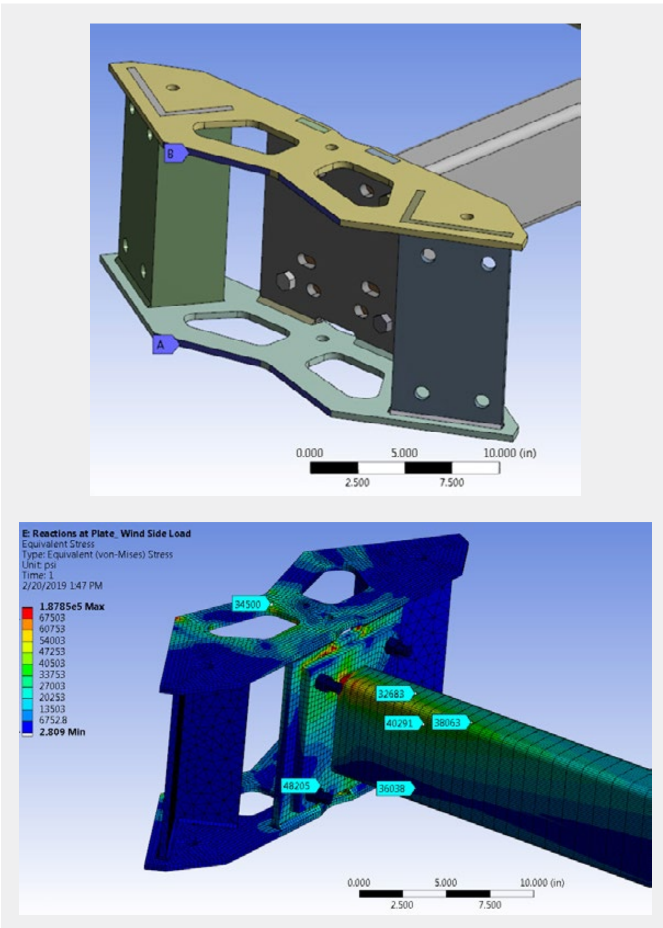

Figure 4: FEA analysis or irritation on collar mount design

While investigating the mount-to-tower connection, we identified monopole designs with thinner plate-steel shafts (less than 3/16 in) that will experience plastic deformation under extreme wind loading conditions. While traditional structures utilize 3/16-in materials, the use of thinner-wall material presented concerns. The decision was made to analyze the monopole shaft diameter in multiple simulations to define the localized effects from the mount-to-tower connection.

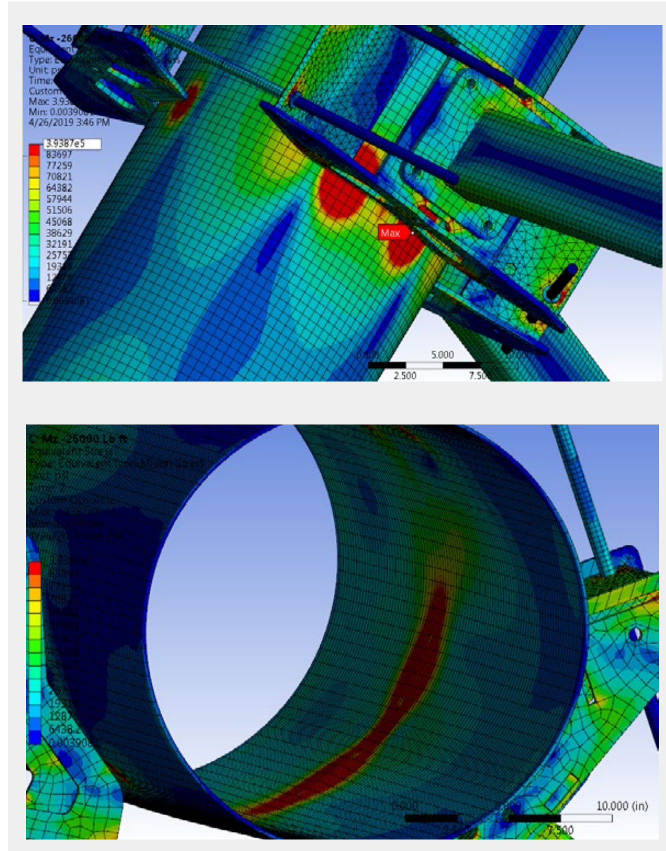

Figure 5: FEA investigation into the mount-to-monopole connection in thin-shafted monopole

Validation through physical analysis

A prototype of the Atlas platform mount was assembled on a test monopole for form, fit and function. The mount was verified with each connection type along with qualitative physical load testing that validated the FEA simulation results.

Figure 6: Physical testing

Conclusion

As mobile operators intensify their 5G roll-out efforts, site and platform engineers are under pressure to make the best use of the available tower/pole space in their macro networks. That will mean finding ways to add more equipment to overcrowded structures.

CommScope's Atlas single-connection monopole platform uses standard structural members and innovative engineering to provide the level of high-load and simplified construction needed. After rigorous design using RISA-3D, SolidWorks, and FEA simulation with ANSYS, the Atlas monopole mount was physically tested under loads to simulate 180 mph wind speed. Additionally, it was analyzed, rated, and verified by a third-party architectural and engineering firm to meet TIA-5053 requirements. This makes the Atlas CommScope's highest-rated single-point monopole platform. More importantly, it provides mobile operators another important tool—helping them meet the industry demand for emerging 5G antenna-integrated radio units.

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