TOWER FOR
MASCOM WIRELESS
BOTSWANA
INNOVATION CENTRE

The concept of a tri-legged aesthetically shaped tower with external working platforms was therefore an attractive alternative, especially as the elegant lines and symbolism of the proposed structure resonates with the architecture of the buildings.

Mascom Wireless, the leading cellular telephone service provider in Botswana, is in the process of constructing a new Innovation Centre in Gaborone, Botswana. To handle the significant flow of data and voice traffic into and out of the Innovation Centre, a tall tower, which has 3600 azimuth (an angular measurement in a spherical coordinate system) and multi-level microwave antenna mounting capacity, is required for the current and future requirements of the Mascom Wireless cellular telephone network.

Due to the close proximity of the Innovation Centre to Gaborone International Airport, Mascom Wireless recognised an opportunity to commission the design of a tower to compliment the new Innovation Centre which would simultaneously satisfy all of the technical requirements that are commonly associated with heavy duty lattice tower structures.

The appointed team conceived an elegant design for a 55m tall tri-legged monopole tower to meet the requirements for an iconic, yet functional structure. The design has the appearance of three elephant tusks standing on end. The functionality of four circular antenna mounting platform levels, built within the tri-legged
The Mascom ‘Cool Tower’ structure is now a landmark in the otherwise urban sprawl of Gaborone and is a prominent advertisement of innovative design and construction using structural steel.

WHY STEEL WAS CHOSEN FOR MASCOM’S TOWER

There are many examples of reinforced concrete telecommunications towers but generally such structures are only economically viable for towers less than 60m tall. These are usually for military installations where a high level of security is essential, or, for taller towers such as the national primary infrastructure for television, radio and telephone communications.

For the Mascom Innovation Centre, the choice was between the traditional structural steel lattice tower, monopole or guyed mast structure. The tower had to have sufficient face area to deploy all planned antennas within height restrictions acceptable to the Civil Aviation Authority. Such structures are normally fabricated from tubular or angle structural steel sections or rolled plate. These traditional structures did not suit the customer not only due to space and height restrictions because of the close proximity to the airport but they also did not complement the architecture of the new Innovation Centre.
Rolled galvanized Grade 355 steel plate was selected for the body of the tower because of the tried and tested methods of seam welding the plates into tapered cones which are then spliced into segments with slip-fitted joints. Internal steel bolted flanges locate the tower segments within the tolerances required for the tapered and curved form and also achieves the precision required for locating the platforms. The resultant form is elegantly slim and aero-dynamically efficient whilst the circular cross-section is structurally efficient. Platforms and associated components were fabricated in tubular and hot-rolled galvanized sections.

WHAT IS UNIQUE ABOUT THE STEELWORK

The basic structural components of this tri-legged tower structure are universally used throughout the cellular telecommunications industry for conventional monopole construction. The unusual and aesthetic application of these basic building blocks is what is special about this structure.

The form of the structures is elegant yet functional – providing a large footprint at the base for stability. The individual legs taper individually and as a group to a point of contra-flexure where the working platforms are accessed from the internally climbable legs. The four platforms anchor the separate monopoles so as to reduce wind generated deflection, thereby providing a steady mounting for the sensitive electronic equipment. The four platform levels are integrated by means of a centralised external access ladder which provides safe use by technical staff. The aircraft navigation warning lights are also readily accessible from the topmost platform for routine service and maintenance, an essential requirement given the proximity of the tower to Gaborone International Airport.

SPECIAL CONSIDERATIONS IN THE DESIGN PROCESS, FABRICATION, TRANSPORT AND ERECTION

The design of the structure was undertaken using several analytical models. Each leg of the tower was analysed as an independent structure with proportional total wind and platform loads. The composite structure with platforms linking the poles was in turn analysed to constrain the deflections to the permissible limits of the articulated pin joint connections between the platforms and the three monopoles.

Various software programmes were used, including Robot, Guymaster and Sectional Poles in-house software, as well as hand analysis.

The individual curved monopole leg elements are constructed of several straight lengths of slip-fitted tapered tubular elements which are bolted together with internal flanges which are offset so as to create the curved shape. Alignment of the straight lengths to prevent twist (like a Kudu horn) was essential, with precision repeated on all three legs so that the completed poles are of equal length, and when erected, the 3-dimensional level and alignment of the platform connecting pins are accurately positioned at three tangent points at heights of 35m, 40m, 45m and 50m respectively.

Erection of tall monopole structures is routine throughout the cellular telecommunications industry. In this case the proximity of the new Innovation Centre and adjacent legs of the tower as well as placement of the four external working platforms, within very tight tolerances, presented an unusual challenge to the rigging team, lead by a 35-year veteran telecommunications tower rigger.
THE STATS OF THE TOWER

Overall height of structure: 55m (plus 2m lightning spikes)
Mass of steel in superstructure: 49 000kg
Cranage: 100 ton mobile crane
Total duration for superstructure: 2 weeks assembly and erection
Area of steel plate in tower legs: 500m²
Diameter of tower legs: Base – 1 326mm, Top – 450mm
Platform levels: 35m, 40m, 45m, 50m
HD Bolts at base of tower leg: 32 x 42mm diameter high tension bolts

CHALLENGES AND SOLUTIONS

Co-ordination of levels and orientation of the civil works were the key challenges to provide an accurate base from which the three legs were launched. This was facilitated by fabrication of a template spanning over the whole footprint of the foundation which was used to level and align the 96 number M42 Anchor Bolts.

Accurate rolling, jigging and welding of the various tapered and slip-fitted leg elements and pre-assembly of the internal flanged joints was the solution to creating the smooth curved pole from straight segments. Precision fabrication by Sectional Poles was required to align all 1 038 connection and splice bolts used in assembly of the structure. The 49 ton superstructure was rigged in five days with a total of two weeks on site required for component assembly and erection.