CORSnet-NSW Adjustable Antenna Mount (CAAM) for GNSS CORS

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Introduction

Global Navigation Satellite System (GNSS) Continuously Operating Reference Station (CORS) networks are being built and expanded around the world, contributing to the definition and realisation of geodetic reference frames as well as providing reliable and accurate positioning infrastructure for a wide range of applications. **CORSnet-NSW** is a rapidly growing network of GNSS CORS providing fundamental positioning infrastructure for New South Wales, Australia that is accurate, reliable and easy to use [1,2].

Figure 1: Current Status of CORSnet-NSW (June 2012).

CORSnet-NSW contributes to the Asia-Pacific Reference Frame (APREF) project [3] and provides a platform for research and innovation involving satellite positioning technology. The network also supports a wide range of GNSS applications in areas such as surveying, agriculture, mining and construction. It is built, owned and operated by Land and Property Information (LPI), a division of the NSW Department of Finance and Services. Currently consisting of about 100 permanent stations tracking multiple satellite constellations, efforts are underway to expand CORSnet-NSW to over 140 stations by the end of 2014 (Figure 1).

GNSS antenna mounts are the devices used to connect the GNSS antenna to the survey monument. The **antenna monument** secures the GNSS antenna mount to bedrock, the ground or the building (or structure) used as foundation. Reinforced concrete pillars and deep-drilled braced monuments are recognised as the most stable and economic GNSS CORS structures acceptable for IGS sites [4]. In Australia, the reinforced concrete pillar is the preferred monument for CORS network stations of national significance.

Regional or state-wide CORS networks, such as CORSnet-NSW, generally also allow free-standing poles and wall monuments securely attached to buildings (Figure 2). These monuments should have widths that are less than the antenna diameter to minimise multipath off the top surface of the monument and to ensure that antenna cables can be easily connected. The distance between the top of the antenna monument and the base of the GNSS antenna should be less than 50 mm or greater than one GNSS carrier phase wavelength [5]. For some GNSS antennas, the monument top must either have a diameter of less than 85 mm or a bevelled edge to allow space for the antenna cable to pass (Figure 3).

Figure 2: CORSnet-NSW free-standing pole and wall monuments.

Figure 3: Antenna monument with bevelled edge.

GNSS Antenna Mounts

Antenna mounts connect the GNSS antenna to the monument. In all cases, it is desired to orient the CORS antenna to True North in order to gain maximum benefit from GNSS antenna modelling. Other requirements generally include the unambiguous definition of the survey mark below the antenna (supporting a clear definition of the Antenna Reference Point, ARP), a zero or minimal antenna height above the monument, and the use of a truly vertical 5/8th Whitworth thread spigot. Given the nature of metal and its tendency to warp when heat is applied through welding or galvanising, great care must be taken to ensure that a level mount top and vertical spigot are achieved.

In Australia, the antenna mount used with national GNSS CORS pillar monuments is a stainless steel pillar plate concreted into place when the pillar top is built. This mount is oriented by placing the intended antenna on the mount, and orienting the mount such that the antenna is correctly aligned to True North. The mount is then secured, the antenna removed, and the mount concreted in place (Figure 4). The four reference pins visible on the pillar top are later used to monitor the stability of the pillar at regular intervals by terrestrial survey methods.

Figure 4: Construction of the GNSS CORS pillar plate at a CORSnet-NSW site.

A number of other GNSS CORS antenna mounts exist, including the Southern California Integrated GPS Network (SCIGN) mount, the SECO 2072-series mount and the UNAVCO fixed-height mount (Figure 5). These mounts need to be installed on top of the antenna monument and have the disadvantage of introducing an antenna height. In most cases, these mounts also contain removable parts, with negative implications on the legal traceability of the ARP.

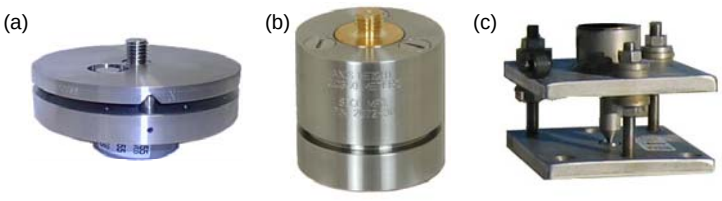

Figure 5: GNSS antenna mounts: (a) SCIGN mount, (b) SECO 2072 mount, (c) UNAVCO mount [6].

CAAM

The **CORSnet-NSW Adjustable Antenna Mount (CAAM)** was developed by LPI and a patent has been issued (Australian Patent No. 2012200770) [7]. It was purposely designed to be incorporated into (rather than simply attached to) stainless steel antenna masts located on buildings and free-standing pole monuments, but can also be used for pillar monuments. The CAAM (Figure 6) incorporates the following design specifications:

- Easily adjustable to True North without introducing an antenna height.
- Clear definition and maximum traceability of the survey mark.
- Integrated into the mount without any removable parts or entry points (e.g. to exclude insects).
- Simple to manufacture locally from readily available parts.
- Robust construction, made entirely from stainless steel.
- Adjustment procedure requiring minimal tools (i.e. one Allen key).
- In case the adjustment mechanism fails (worst case scenario), the survey mark is still usable.

Figure 6: Internal workings of the CORSnet-NSW Adjustable Antenna Mount (CAAM), patent issued.

Using three adjustment screws, the vertical position of the 5/8th Whitworth thread spigot can be adjusted slightly to ensure the antenna is oriented to True North without the introduction of an antenna height (Figure 7). Turning the screws clockwise raises the centre spigot a tiny amount, allowing the antenna more rotation before it tightens. If one screw is rotated more or less than the others, the spigot will naturally try to tilt to one side. However, due to the thickness of the top plate it is not possible to adjust the three screws unevenly to any significant degree. A small tolerance allows the centre spigot enough freedom to move within the top of the mount during the adjustment process, while still keeping it vertical to within 0.25 mm.

The spigot is adjusted as follows:

1) Screw the GNSS antenna on firmly and take note of how far the antenna is required to rotate (clockwise or anti-clockwise) before it faces True North.
2) Remove the antenna.
3) Turn each of the three adjustment screws using an Allen key. If the antenna needs to rotate 30° clockwise, turn each of the three screws approximately 30° clockwise.
4) Screw the antenna on firmly again and check for direction.
5) Repeat this procedure until the direction is correct.

Figure 7: CAAM, integrated into the GNSS antenna monument.

Contrary to conventional antenna mounts, if a GNSS antenna needs to be replaced, the new antenna can be installed and oriented to True North without introducing (or changing) an antenna height and the physical survey mark remains unchanged. Another feature of the CAAM is that after the antenna is in place, the orientation cannot be altered without actually removing the antenna first. This provides an additional level of security. Design sketches for the CAAM are freely available and shown in Figure 8.

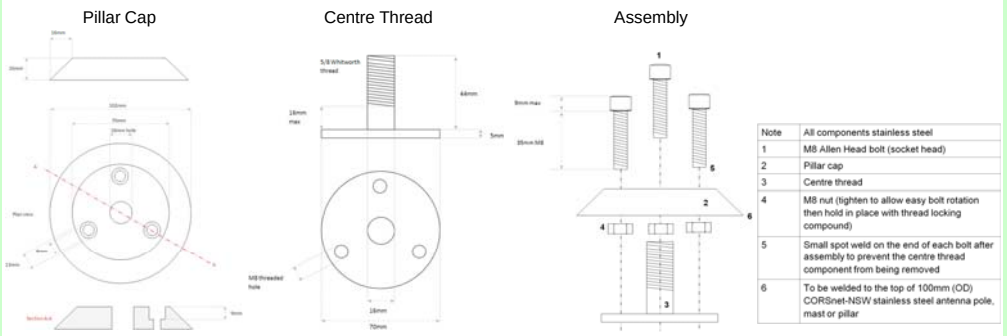

Figure 8: CAAM design sketches, patent issued [7].

Conclusions

Antenna mounts are an essential part of any GNSS CORS installation. Currently available GNSS antenna mounts are not ideal because they need to be installed on top of the antenna monument, thereby introducing an antenna height. Often, these mounts also contain removable parts, which negatively affects traceability of the survey mark and the ARP.

The CORSnet-NSW Adjustable Antenna Mount (CAAM) addresses these disadvantages, providing an easy-to-use alternative that is free of removable parts and integrated into the antenna monument. It was purposely designed for CORSnet-NSW CORS installations which use antenna masts attached to buildings and free-standing pole monuments. However, the CAAM can also be used for concrete pillar monuments, thereby eliminating the need to introduce an antenna height if an antenna is replaced. LPI encourages adoption of the CAAM.

References

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