RADCOM TECHNICAL FEATURE

The G8PO Triangle Sloper

by Ted Ironmonger Cdr, OBE, RN (Rtd), G8PO.

A simple directional antenna for 80 metres and other low bands

CONTACTS WITH New Zealand, via the long route on 80 metres, have fascinated me for many years. The perplexing question as to whether propagation is by normal multi-hops, chordal-hops etc, or even increased by 'antipodal focusing' has always been a compelling incentive for experiments with many friendly ZLs. Perhaps memories of the first ever G-ZL contacts by G2DX and G2NM, way back in 1927, also drives me on.

The antennas used for such observations at a favourable location near the sea have, in the past, been a relatively simple inverted V, and a gamma-fed tower. However, with deteriorating sun spot activity creating even more interest in the lower bands, it became evident that an improved simple directional radiator was required to compete with the mushrooming LF Quads, yagis, vertical arrays etc.

INITIAL DEVELOPMENTS

SPACE LIMITATIONS AT G8PO precluded anything very elaborate, so a $^1/_4\lambda$ sloper was investigated. The garden is 70 x 150ft with a 40ft tower, TH3 Yagi on top, and facilities to haul up wire antennas. The conventional arrangement was tried, ie coaxial feed to the top of the existing 40ft metal tower, braiding bonded to the top of the tower and inner conductor connected to approximately 66ft of wire sloping at 45° to the SW.

Results were average for a sloper, with some gain compared to a permanently rigged reference inverted-V but the system was difficult to match. I felt this was due to the 'relatively' high impedance point at the base of the 40ft mast being earth, ie 40ft down from the low impedance feed braiding connection - workable but not ideal. A further major problem was the need to lower the tower for installation and repairs.

Instead of connecting the braiding to the top of the tower a separate 38ft wire conductor was used alongside the mast and the whole sloper hauled into position on a halyard. The 38ft vertical wire was spaced approximately 12 inches from the tower by fixing at the base, and insulated from ground.

Results were similar to the tower connection, but the fitting arrangements were an advantage for experimentation and repairs. Matching was still a problem, however.

MATCHING TRIALS

IN AN EFFORT TO PROVIDE facilities for better matching, the spaced 38ft vertical wire was lengthened to approx 66ft (ie as for the sloping element) and the 28ft extension run horizontally at ground level - approximately 12in above ground to the *rear* of the mast.

The coaxial feeder was cut to a half wavelength on 3.5MHz, allowing for its velocity of propagation. This is approximately 88ft for the present sloper. With the above arrangement, satisfactory matching was achieved by lengthening or shortening the wire elements and checking SWR at the shack.

This may appear tiresome but is in fact a most simple and effective method - a low SWR can be achieved with patience, and neither a balun nor ATU is required. On the air checks with ZL indicated that progress was being made, but I still felt a better configuration could be developed.

FURTHER INVESTIGATIONS

VARIOUS HANDBOOKS were consulted to ascertain how a sloper really works [1, 2] and the following came to light. Firstly, some directivity is obtained by sloping the wire in the direction required and this holds good even when the radiator is only a quarter-wave long. Secondly, from W6SAI's *Antenna Handbook*, a quarter-wave sloper can be considered as a 'tilted', one radial ground plane.

It should be noted that such a ground plane has maximum radiation in the direction of its simple radial. Deductions from the foregoing indicated the directivity could perhaps be due to a combination of factors:

(a) Maximum radiation in the direction of the slope.

(b) Some radiation from the direction of the 'built in' tilted ground plane's radial element, which could possibly be modified to advantage.

I wondered whether these two directional properties (if they both exist!) could be made to add by element rearrangement? It was not possible to tilt *both* the wire elements (the sloping and vertical sections) - this had appeared as a possible way of combining the directional properties of each. However, another compromise was found.

FINAL ARRANGEMENT

AFTER FURTHER STUDY AND TRIALS, the arrangement of **Fig 1** was found to be the best practical solution. It is simple to put up and can be accommodated in the average garden.

Note how the lengths have been changed from the original experiments - those shown

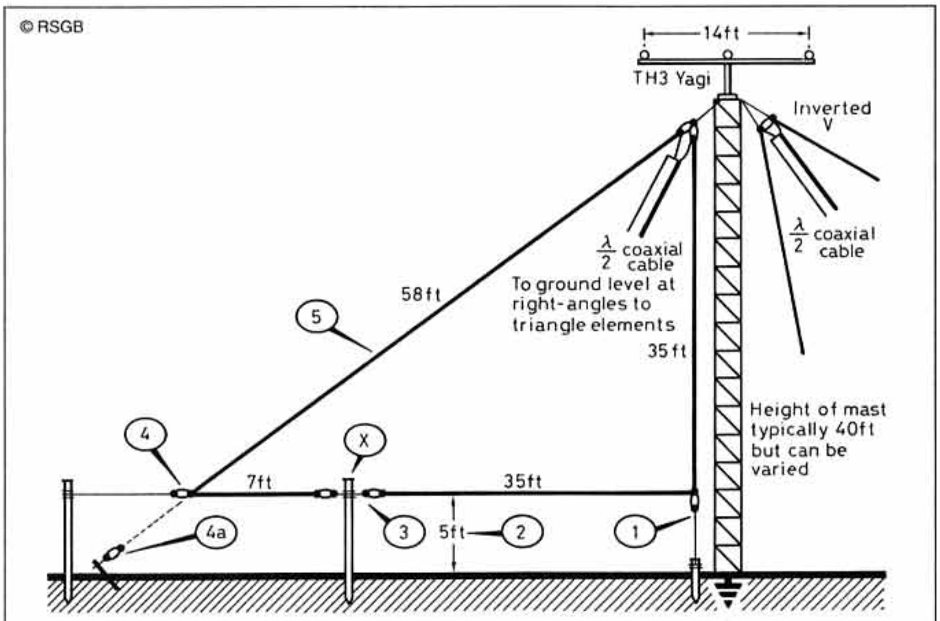

Fig 1: The Sloper is fed with 52Ω coax. The numbers are explained in the notes on the opposite page.

are typical for the shape depicted and achieve the lowest SWR at my own QTH. The lengths are given as a guide only and must be finalised on site, when the shape to suit the user's location has been decided.

Start with approximately the lengths shown. Remember that the two high impedance ends, readily available at ground level, are adjusted for length and end spacing to give the lowest SWR. Also, the spacing between the down side of the triangle sloper and the metal mast also affects matching. This too should be adjusted as necessary.

To aid initial installation and allow speedy length changes, it is recommended that the last 5ft of the ground level elements be temporarily made from easily stripped and twisted wire. All the above is an area for on-site experimentation and, being so accessible, I find it a pleasure to adjust for best results!

REFERENCE ANTENNA

AN INVERTED-V REFERENCE antenna, is permanently rigged on the same mast as the 'Triangle Sloper'. Both antennas are fed with half-wave coax feeders and separation of feed points is approximately 2ft, some interaction must take place but checks indicate degradation is minimal. Both feeders come away at 'right-angles' to the triangle sloper elements. For receive comparison tests, I monitor the Portuguese commercial station CTP (3782.9kHz) which is roughly in the ZL long-path direction and a useful indicator. A low take-off angle is required for this station at midday and the signal is invariably stronger on the Sloper - often plus 12dB.

MAST INTERACTION AND RADIALS

THE 40FT METAL MAST is top loaded with a three element all metal yagi. Readers may wonder what part this plays in the triangle slopers performance? This is not known, it is not easy to remove for a trial!. However other stations have used normal slopers hung from wooden masts and they have performed satisfactorily (see pages 133-137 of [2]). I am aware that the metal structure must have some effect - a computer simulation would show that it affects both performance and feed impedance.

However, unlike a 3.8MHz gamma-fed tower - where top loading for resonance, with a 40ft mast, is a big advantage, this is possibly not the case with a triangle sloper. Many users are certain that a top loading Yagi is essential in similar circumstances (ELNEC checks indicate this). However see the section on 'suggested experiments' with regard to this. Ground radials were tried with the triangle sloper, but many tests with ZL indicated they gave no improvement. Note the voltage and current distribution in **Fig 2**, this is most interesting, perhaps the experts should analyse it?

SAFETY CONSIDERATIONS

PROTECTION IS RECOMMENDED at point X (Figs 1 and 2), as the RF voltage here can be very high and dangerous. I am not aware of many other antennas where one can put fingers across both ends of the driven element!

CONCLUSIONS

THE NORMAL SLOPER is an effective, simple, directive antenna but the triangle arrangement appears to give an improved performance - perhaps a further 3dB of gain and lower angle of radiation although this is difficult to measure. However, reports and reception from ZL are most encouraging, after 14 days of use in October 1992, many ZLs on 80 metres were asking over the air, "What has happened at G8PO?" - the signal had apparently improved significantly!

It should be remembered that the only change made was to a triangle configuration, and that the metal mast had also been used with the two previous types of sloper! The antenna is easily rigged and matched for the designed band, and is particularly useful on 160, 80 and 40 metres as a compact system. It can be 'hand rotated' around 360° for directivity, even on 160 metres! I still feel the less fortunate could be surprised when they make trials using other types of antenna supports and if necessary try three fanned wires behind the support.

A polar diagram has not been taken but beam width would appear about 60°, covering from ZL1 to ZL4 adequately. Front to back ratio, against the reference inverted-V, is approx 12db. Radiation is relatively low angle (G3GSI/G3FYS 'ELNEC' checks indicate about 20°), and bandwidth at least 250kHz.

Recent tests have indicated the antenna can easily be screened and a clear take-off particularly at very low angle is essential if the system is to perform satisfactory.

IDEAS AND SUGGESTIONS

READERS MIGHT LIKE TO TRY one or more of the following:

1) Try the triangle at different heights and in different related shapes.
2) Experiment with possible multi band operation, eg where harmonically, the feed point becomes low.
3) Try a 40/80 metre trapped inverted-V in a semi-triangle sloper configuration. It could possibly work as a triangle on 80 metres and a normal sloper on 40 metres.
4) If both wooden and top loaded metal masts are available on site, rig a triangle sloper on each and compare the results!
5) Try the sloper as a self supporting metal rotating device, on one of the higher bands.

ACKNOWLEDGEMENTS

THE WRITER WISHES TO THANK the very many 80 metre operators for their time and patience in reporting and commenting on the Triangle Sloper 'trials'. In particular ZLs: 1BOQ, 1CCR, 2JR, 2SN, 2APW, 3GS, 4AP, 4BO and last but not least 4KF.

REFERENCES

[1] *The ARRL Antenna Handbook*, ARRL [16th edition now available from RSGB sales - see *BookCase* pages - *Ed*].

[2] *The Radio Amateur Antenna Book*, by W6SAI and W2LX.

FIG 1: NOTES

1) Spacing adjusted (approx 12in) for minimum SWR.
2) Adjust height as required.
3) End spacing and length is trimmed for lowest SWR.
4) Turn-under of sloping wire is not critical.
4a) Ground level fixing could be used in lieu.
5) Slope not critical, can be 40-60°.
X) Volts at point X are high, protection recommended.

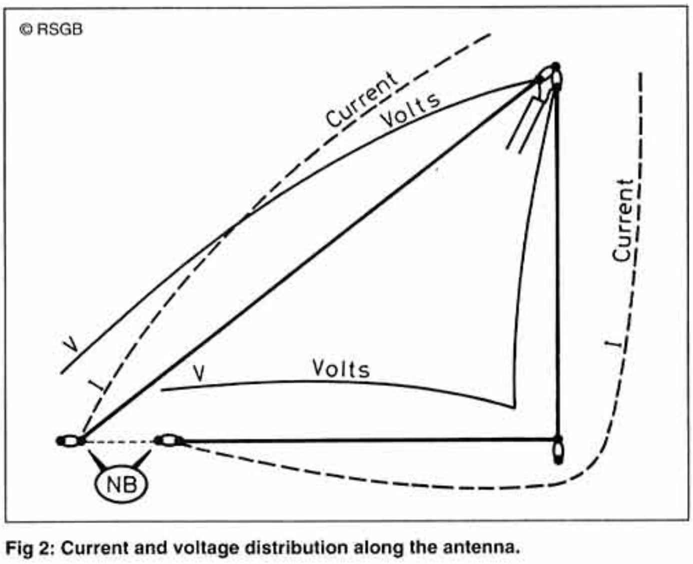

Fig 2: Current and voltage distribution along the antenna.