The Half Sloper — Successful Deployment is an Enigma

That new leaning-wire DX chaser you've installed may be the "in" thing, but VE2CV puts a new slant on the sloper that may change your thinking about it!

By John S. Belrose,* VE2CV

The so-called half-sloper antenna seems to have reached its heyday. Bill Orr, W6SAI, for years has lauded the performance of slopers. George Smith, W4AEO, writing in *73 Magazine,* has discussed both full- and half-sloper antennas. Dana Atchley, W1CF, and Doug DeMaw, W1FB, have recently published their comments in *QST.*[1-6]

An antenna of this configuration consists of approximately 1/4 wavelength of wire that slopes from the top of a tower. An angle of 45 degrees between the wire and ground level is considered appropriate. Termination of the far end of the antenna may be placed from 5 to 15 feet (1.5 to 4.6 meters) above ground. The general practice is to feed the antenna with 50-ohm coaxial cable, the center conductor of which is connected to the antenna and the sheath connected to the tower at a position adjacent to the feed point. Some amateurs tape the cable to the outside of the tower, but others prefer to pass the cable through the center of the tower in an effort to minimize any effect of the radiated field on the transmission line.

Among the many radio amateurs who have slopers, there are those who claim that a perfect match has been attained by employing a sloping wire cut to the traditional length for a 1/4-wave radiator but shortened 5%. Others have found that the wire had to be 8% longer than 1/4 wavelength. Still others have found that with a tower shorter than 1/4 wavelength, the radiator had to be considerably shorter than a 1/4-wave antenna. Bob Lunsford, formerly WB4DPG/5, found that the best match is obtained when the end of the antenna is parallel to the ground and close to the earth for some distance.[2] From all this, one must infer that there does seem to be a problem in regard to resonating and matching the impedance of the antenna.

Concerning performance, some amateurs have reported good results with this type of antenna. Others have been unable to make it work or became discouraged when they failed to make it resonant. The azimuthal and elevation patterns for the antenna are unknown. In some descriptions of the half sloper, the tower is thought to be like a reflector, providing some directionality to the azimuthal pattern. Most amateurs who have used the antenna agree that it should be a good radiator because the current maximum is generally in the clear, being at the top of the radiator rather than appearing near the bottom, as would be the case with a 1/4-wave vertical antenna.

Although the author of this article has not used the half sloper for 80 or 40 meters, he has modeled the antenna at 200 MHz, measured its impedance and graphed polar diagrams on a professional antenna-pattern range which is over a perfectly conducting ground plane. This article discusses these results.

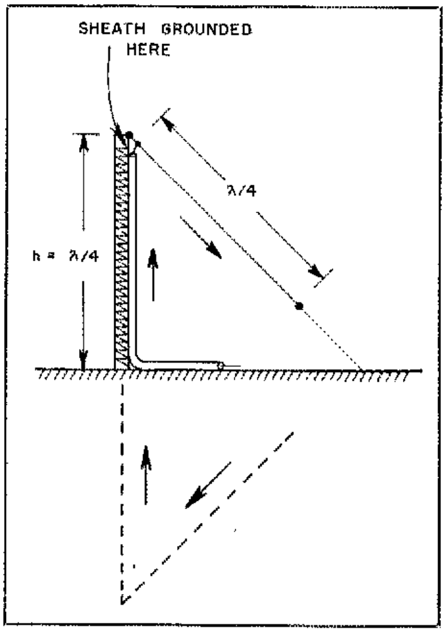

Fig. 1 — A half-sloper antenna showing method of feed and the ground image. The arrows show the instantaneous direction (phase) of current flow on the antenna and its image.

Resemblance to a Delta Loop

A half-sloper antenna and the image on the ground plane are shown diagramatically in Fig. 1. It is clear that if the antenna were fed at the far end, with the sloping wire connected to the top of the tower, the radiator would indeed be a half delta loop (the other half for full-wave resonance is the image of the antenna in the ground plane). The antenna, however, is fed at the top of the tower with the far or lower end open-circuited. It must radiate, therefore, like some form of bent grounded 1/2-wave radiator or perhaps like a top-fed, top-loaded vertical radiator. Previous users of this antenna have considered it to be of the former type.

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[1]References appear on page 33.

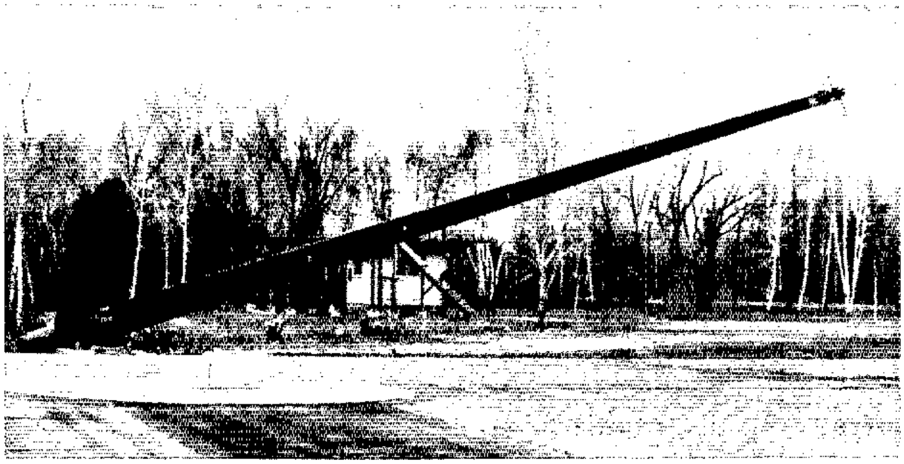

Fig. 2 — Photograph of antenna-pattern range showing boom for measuring vertical pattern, and flush-mounted turntable for measuring the azimuthal pattern.

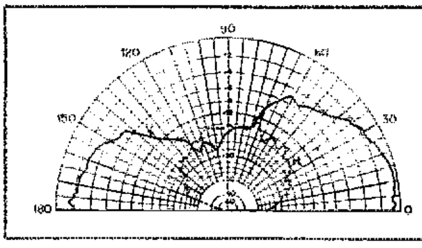

Fig. 3 — The solid line (V) represents the vertical pattern for vertical polarization measured in the plane containing the sloper and the tower. A graphical representation of the vertical pattern for horizontal polarization measured in the plane perpendicular to that containing the sloper and the tower is shown by the dashed line (H).

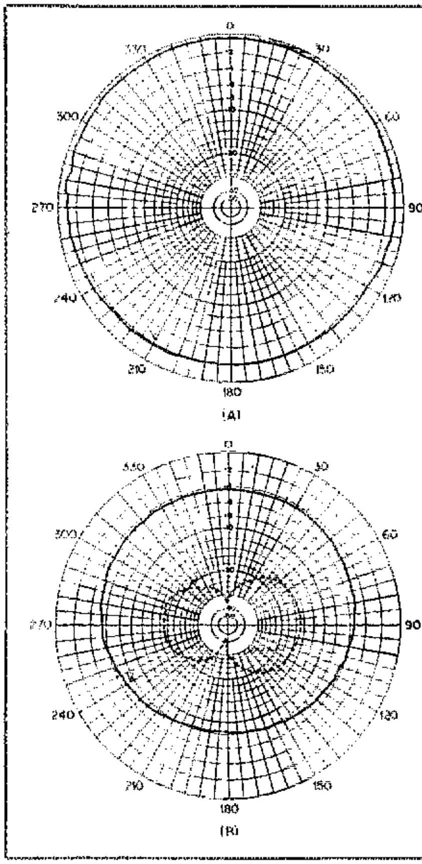

Fig. 4 — Azimuthal patterns for vertical polarization measured at elevation angles of 10° and 45° above the horizon are shown by solid lines in A and B, respectively. A figure-eight azimuthal pattern for horizontal polarization measured at 45° elevation is represented by the dashed line in B.

The sloper the author built was 1/4 wavelength long, calculated by the usual formula for wire antennas in which there was an allowance of 5% for shortening from a free-space quarter wavelength. The tower is physically 1/4 wavelength high. In order to obtain a repetition of the antenna feed-point impedance at the transmitter end of the transmission line, the transmission line was 3/2 waves long.

Tests disclosed that the antenna did not resonate at the design frequency (200 MHz). Measurements indicated the impedance to be 150 + j190 ohms. None of the adjustments of the antenna parameters (height of the tower or length of the sloping wire) resulted in obtaining resonance. Next, the configuration was changed so that the coaxial cable passed upward through the center of the tower. Little difference was found. Obviously, since the antenna would not resonate when driven from a transmission line of random length, the apparent impedance could be anything, depending on the electrical length of the line. This seems to agree with the results of other amateurs.

The Polar Diagrams

Data for the polar diagrams shown in this article were obtained from measurements made on a professional antenna range. This ground-level pattern range is 70 feet wide by 200 feet long (21.4 × 61 m). It is laid out in the form of a wire grid at one end of which is a copper-clad, flush-mounted turntable that is 20 feet (6.1 m) in diameter.

The model antenna was placed at the center of this rotatable part of the test range. A counter-balanced boom at one edge of the range can be swung overhead to measure the vertical pattern for either vertical or horizontal polarization (see Fig. 2). We did not attempt to match the impedance of the sloper. Therefore, the relative gain with reference to a monopole, for example, was not measured.

Our sloper radiated essentially like a grounded-monopole vertical radiator. The radiated field was dominantly vertically polarized and the azimuthal pattern was essentially omnidirectional. The horizontally polarized component, which is maximum in the plane broadside to that containing the sloper, was 10 dB down from the vertically polarized field.

Various measurement patterns are illustrated in Figs. 3 and 4. In Fig. 3, we show the vertical pattern for vertical polarization measured in the plane containing the sloper and the tower; and the vertical pattern for horizontal polarization measured in the plane perpendicular to that containing the radiator and the tower. In Fig. 4, we show the azimuthal pattern for vertical polarization at elevation angles of 10 degrees and 45 degrees above the horizon. The azimuthal pattern for horizontal polarization at 45 degrees elevation (Fig. 4) shows that for horizontal polarization, the field is maximum in this direction. In Fig. 4 the sloper and tower are aligned along the 0- to 180-degree axis.

Discussion

In view of the foregoing, the questions I ask myself are: (1) What does the antenna have going for it? Personally, if I had a single, grounded 1/4-wave tower, I'd employ a full-wave delta loop, apex up, lower corner feed — the best DX-type antenna I've modeled. But that is another story. An alternative is to excite the tower as a folded unipole or as a half delta loop. (2) How were the users of the antenna able to get a good match when the impedance differs so markedly from that of the 50-ohm feed line? Undoubtedly, therein lies the explanation of the difficulty many amateurs experienced when attempting to resonate the antenna. Doug DeMaw's note reveals that indeed the input impedance is probably high. He found that when the feed point became covered with ice the antenna was rendered useless. The SWR reading was full scale under those conditions.

George Smith, W4AEO, suggested grounding the sloping wire to the tower and end feeding the lower end of the sloping wire. He points out that by doing so one could avoid installing cable from the bottom to the top of the tower, an expense- and labor-saving advantage. Indeed, if we visualize this method of feed (refer to Fig. 1), we can see that the anten-

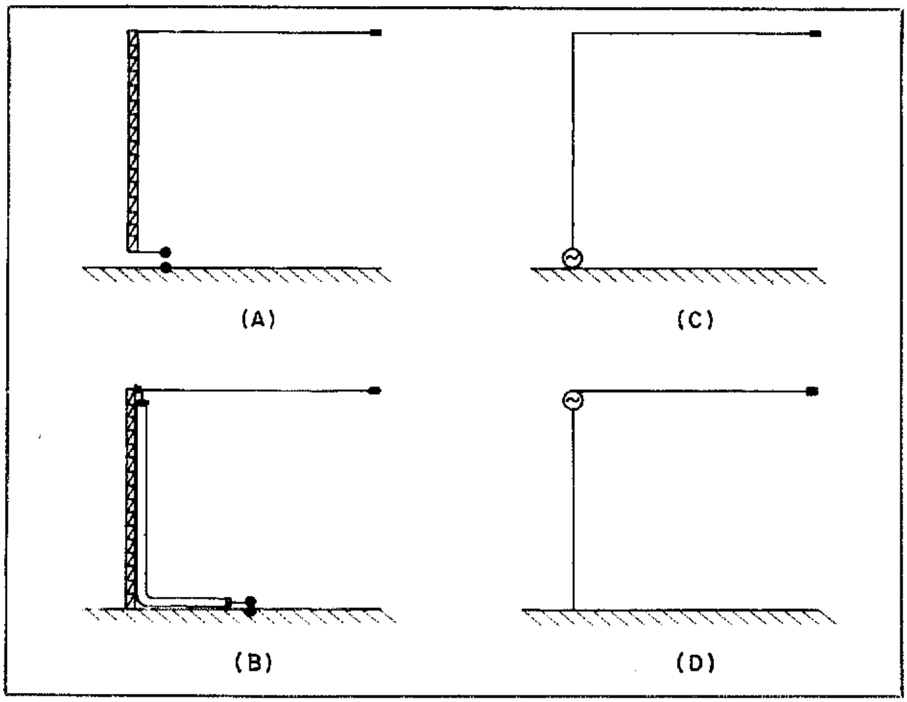

Fig. 5 — Actual and equivalent circuits for base-fed (A and C) and elevated feed (B and D) L-type antennas.

na type is clearly a grounded vertical half-delta loop (the loop is full-wave resonant since the other half of the loop is formed by the image in the ground plane).

What do we conclude about performance? Doug DeMaw has made glowing claims about the performance of his 40-meter sloper; for him, in fact, the antenna does work mighty well. Doug previously used a half-wave (a full-sloper) antenna. I have not used the half-wave sloper but had thought it to be a good one. If it is an effective radiator, then I believe the 1/4-wave sloper cannot be 10 to 20 dB better. So we haven't entirely resolved the enigma of the sloper.

Further experiments with the antenna, after we completed the antenna-pattern measurements, included measurement of the SWR over a very wide frequency range For this purpose, we used a sweep-frequency signal generator, an SWR bridge and an oscilloscope display. Curiously enough, the antenna was found to be resonant at a frequency very much lower than any for which we had previously made impedance measurements. The antenna resonated at 134 MHz and near 283 MHz rather than at 200 MHz. This suggests that the antenna is, in fact, a type of top-loaded vertical monopole. It further indicates that users of this antenna should be aware that the operating frequency is above the self-resonant frequency of the antenna by a factor of about 1.5.

This interpretation is made clear in Fig. 5, where we show actual and equivalent circuits for (A) a conventional insulated-base, base-fed antenna and (B) an antenna, like the half sloper, with elevated feed (fed with coaxial cable at the top of the mast). The equivalent circuits are shown in (C) and (D) respectively; i.e., the feed arrangement shown in (B) is equivalent to inserting the generator between the mast and the top loading. The half sloper is an L-type antenna in which the upper arm is sloping instead of being horizontal. More exactly, it is an umbrella-type radiator in which the "active guys" have been reduced to one.

In conclusion, I do not recommend the use of this antenna. The radiator is nonresonant for frequencies near those expected. The pattern is essentially omnidirectional. This same pattern can be obtained by using a more sensible arrangement of feeding a grounded quarter-wave tower, such as converting it into a folded monopole or a half-delta loop.

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[1]Orr, "Antennas" *CQ Magazine*, September 1975, pp. 41-44. The author describes an 80-meter sloper antenna built by W6MZ.
[2]Orr, *CQ Magazine*, February 1976, pp. 46-48.
[3]Orr, *CQ Magazine*, February 1976, pp. 44-46.
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