Interaction Notes

Note 382

February 1980

SOME COMMENTS ON MAGNETIC POLARIZABILITIES

William A. Davis

Virginia Polytechnic Institute and State University

Some Comments on Magnetic Polarizabilities

William A. Davis
Virginia Polytechnic Institute and State University

Recently I was reviewing the literature on coupling by small apertures. The most common reference to numerical polarizability results for apertures was the work of De Meulenaere and Van Bladel [1]. However, the results have a critical error in the presentation. A point of interest also may be made concerning the remaining results which have implications about the discretization process. In this communication, I will discuss the error of De Meulenaere and point out the other interesting features of the work.

The error is in the plotted values of the scaled magnetic polarizibility component ν_{my} for the cross. This data is currently appearing without correction in the electromagnetic pulse literature. To form a basis for the correction let us first consider the data of $1/\nu_{mx}$ for the cross and rectangle. This data may be inverted and multiplied by the three-halves power of the surface area to obtain the xx-component of the magnetic polarizability. In this case, the magnetic field is parallel to the long dimension of the rectangular slit and we would expect the cross and rectangle to have similar xx-component magnetic polarizabilities. Fig. 1 presents the data of $(1/\nu_{mx})$ for the rectangle and cross given by De Meulenaere and Van Bladel along with the rectangle data rescaled to the cross dimensions. As expected, the scaled data is similar to the cross data with a slight increase in ν_{mx} for the cross in the middle range of w/ℓ, a result of the slight increase of magnetic coupling in the upper and lower regions of the cross.

Observing the symmetry of the cross, we have that ν_{my} is equal to ν_{mx}. I have plotted ν_{my} for the cross in Fig. 2 as obtained from ν_{mx} in Fig. 1. The ν_{my} for the cross and rectangle obtained from De Meulenaere and Van Bladel have also been plotted with an error noted in ν_{my} for the cross. It is possible that the ellipse data was plotted by the authors and mislabeled as the cross. This conjecture is further supported by the intersection of the curve in error and the rounded-off rectangle at a value of 0.479 for $w/\ell = 1.0$. This is the ν_{my} for the circle which is the limiting geometry of the ellipse and the rounded-off rectangle.

An interesting feature may be observed in the plots of De Meulenaere and Van Bladel. For the diamond and rectangle at $w/\ell = 1.0$, they obtained 0.54 and 0.51 respectively for ν_{mx} (and ν_{my}). The coordinate rotation to go from the square rectangle to the diamond does not change the magnetic polarizabilities of a square. We may thus conclude that the six percent variation in the plotted data for w/ℓ is due to the discretization method incorporated in the solution.

These corrections and observations will hopefully enable other researchers to properly account for the effect of the concave nature of apertures in their bounding and approximation research.

REFERENCE

[1] F. De Meulenaere and J. Van Bladel, "Polarizability of some small apertures," IEEE Trans. Antennas Propagat., AP-25, Mar. 1977.

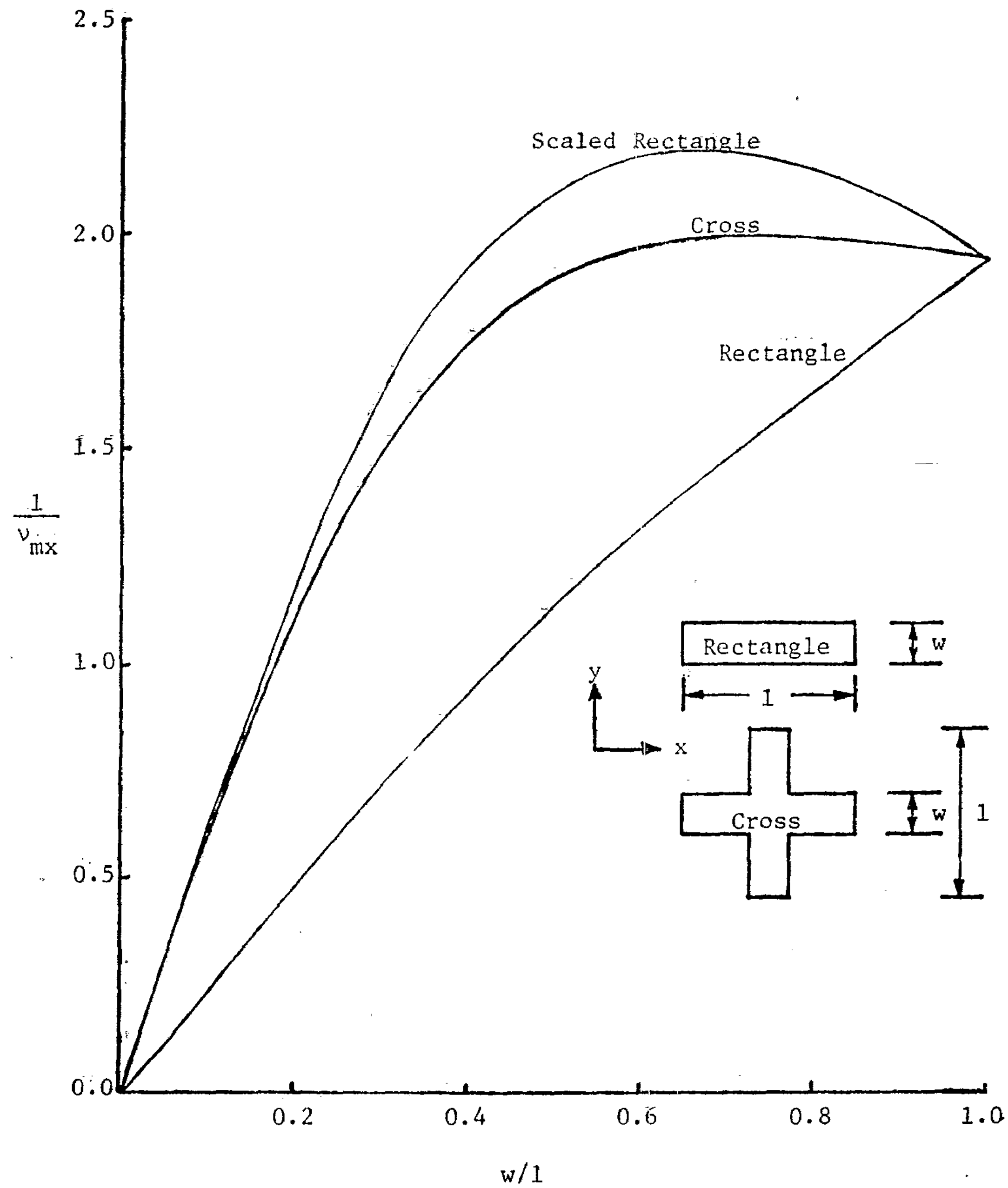

Figure 1. Scaled xx-magnetic polarizability versus width-to-length ratio.

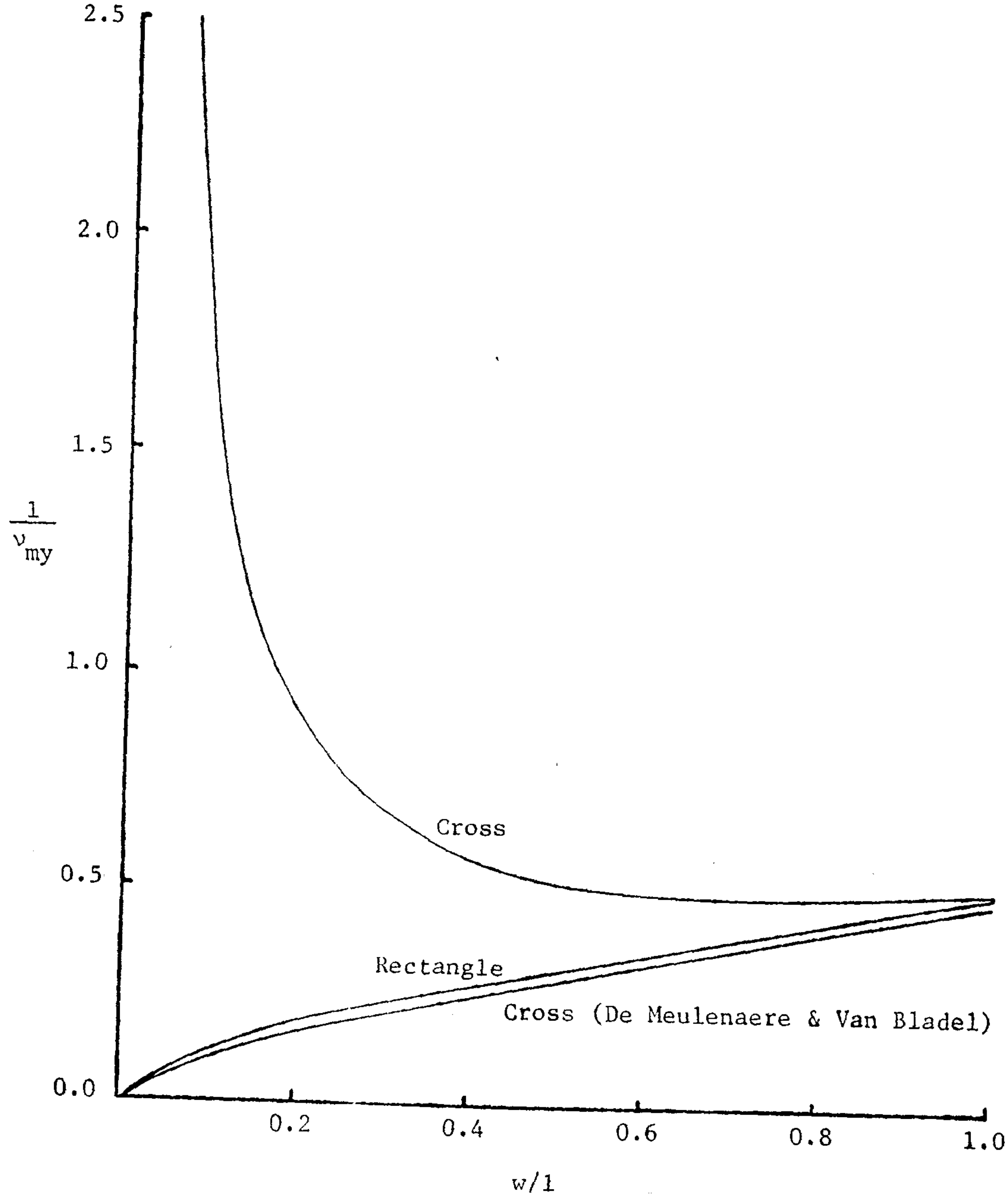

Figure 2. Scaled yy-magnetic polarizability versus width-to-length ratio.