



# Surface Waves on Stealth Aircraft

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## Full title

### The Characterization of Surface Waves on Low-Observable Structures

being a Thesis submitted for the Degree of

Master of Science

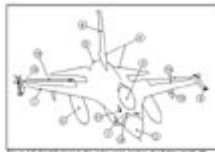
in the University of Hull

by

**Ing. Serge Yves Marcel Roland Stroobandt**

August 1997

# Highlights



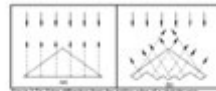
**Figure 11** Contributions to the radar cross section of a light aircraft

Edge scattering contributions arising due to reflections are:  
 1) Diffraction caused by the leading edge  
 2) Diffraction caused by the trailing edge  
 3) Diffraction caused by the wing root  
 4) Diffraction caused by the fuselage  
 5) Diffraction caused by the tail

Scattering contributions that result from rough, but not necessarily wet, surfaces are:  
 1) Scattering from rough surfaces  
 2) Scattering from rough surfaces  
 3) Scattering from rough surfaces  
 4) Scattering from rough surfaces  
 5) Scattering from rough surfaces

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Contributions to the RCS can be categorized by surface wave propagation modes in the following manner:



**Figure 12** The diffraction of waves at a sharp corner



**Figure 13** The leading edge of the wing



**Electromagnetic**

$$E_{\theta} = \frac{1}{4\pi r^2} \left[ \frac{d^2 p_{\theta}}{dt^2} \sin^2 \theta + \frac{d^2 p_{\phi}}{dt^2} \sin \theta \cos \theta \right]$$

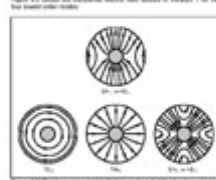
$$B_{\phi} = \frac{1}{4\pi r^2} \frac{d^2 q}{dt^2} \sin \theta$$

**4.1 Field Distribution of Axial Surface Waves along a Conical, Electrically Conducting Cylinder**

Because of the cylindrical symmetry of the field functions  $E_{\theta}$  and  $H_{\phi}$ , both within the limits of equation (1) for the given  $\theta$  value. They can be expressed by  $E_{\theta}$  and  $H_{\phi}$  and the corresponding modes are either  $TM_{n,m}$  or  $TE_{n,m}$  or  $TM_{n,m}$  or  $TE_{n,m}$ .

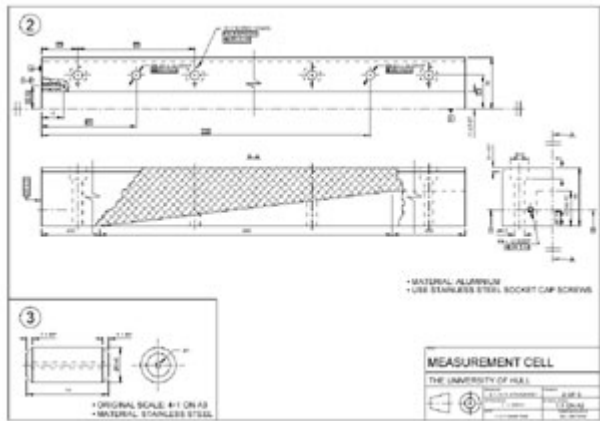
The  $TM_{n,m}$  modes are characterized by the fact that the electric field is directed along the axis of the cylinder.

The  $TE_{n,m}$  modes are characterized by the fact that the magnetic field is directed along the axis of the cylinder.



**4.2 The Plane Surface Wave Scattering Cell**

A plane surface wave scattering cell (Fig. 4.2) has been designed to measure the complex plane constant of a half-space of a plane surface wave. The scattering cell is a rectangular block of dielectric material with a flat top surface. The scattering cell is used to measure the complex plane constant of a half-space of a plane surface wave. The scattering cell is used to measure the complex plane constant of a half-space of a plane surface wave.



# Abstract

Edge diffracted waves resulting from surface discontinuities contribute significantly to the radar cross section of an object. Although this problem could be alleviated by altering the shape of the edge discontinuity, this is not always possible due to other mission requirements.

The backscatter from edge diffracted waves may also be reduced by converting the incoming radar waves into surface waves whose intensity is significantly reduced before reaching the surface discontinuity. This can be achieved by employing isotropic surface wave absorbing materials backed by a metal surface. However, for plane surface waves, the effectiveness of these materials is shown to be strongly polarization dependent.

This work suggests a new strategy which involves replacing the scattering surface by an electromagnetic soft surface. This would result in a complete elimination of the edge diffracted waves in the radar direction, independently of radar polarization.

Furthermore, a new measuring apparatus based on a partially filled rectangular waveguide has been developed for determining the attenuation constant and phase constant of plane surface waves propagating along metal-backed surface wave absorbing materials. Measurements are presented which validate this new measuring method.

## Keywords

Radar Cross-Section (RCS) Management, Surface Waves, Radar Absorbing Materials, Electromagnetic Measurements

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# Publications

-  S. Y. M. R. Stroobandt and F. C. Smith, “Method for measuring the attenuation and phase constants of a surface wave propagating along an infinite plane,” *Electronics Letters*, 33(20):1685–1686, September 1997

-  F. C. Smith and S. Y. M. R. Stroobandt, “The design principles and measurement of surface wave absorbing materials,” *Progress in Electromagnetics Research Symposium (PIERS) Proceedings*, Volume 1, page 369, July 1998



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