Table 1 **Eigenfrequencies and amplitudes of a 100-m-diam hoop-column antenna ($a = 100$ m, $e = 1$ m, $\alpha = 1$, $\omega = 1$)**

n	λ_n	A_n	λ_n (predicted by by the simple model[3])
1	0.244	$0.3200\ \Pi^2 A$	0.119
2	0.398	$0.4600\ \Pi^2 A$	0.214
3	0.513	$0.0016\ \Pi^2 A$	0.271
4	0.603	$0.0020\ \Pi^2 A$	0.506
5	0.681	—	0.721
6	0.754	—	0.890
7	0.823	—	0.919
8	0.956	—	1.009

Table 2 **Comparison between the simple model and the finite element model**

Antenna model	Ratio of eigenfrequencies						
Simple model	1.7	1.29	1.18	1.13	1.11	1.09	1.16
Finite element model[3]	1.8	1.26	1.87	1.42	1.13	1.03	1.18

$$+ \sum_{n=1}^{\infty} A_n \left[\frac{-Y_0(\lambda_n e) J_0(\lambda_n r)}{J_0(\omega e/\alpha) Y_0(\omega\, r/\alpha)} + Y_0(\lambda_n r) \right] \sin(\alpha \lambda_n t) \qquad (3b)$$

The coefficients A_n, $n = 1,2,\ldots$, are to be obtained from the initial conditions (1b-1e) and the Bessel-Fourier series expansion and are given by[4]

$$A_n = \frac{\Pi^2 \lambda_n J_0(\lambda_n e)[L_1 - L_2 - L_3 + L_4]}{2\alpha[J_0^2(\lambda_n e)/J_0^2(\lambda_n a) - 1]} \qquad (4a)$$

where

$$L_1 = \int_e^a r\, \bar{k}_1 Y_0\left(\frac{\omega r}{\alpha}\right) Y_0(\lambda_n e) J_0(\lambda_n r)\, dr \qquad (4b)$$

$$L_2 = \int_e^a r\, \bar{k}_1 Y_0\left(\frac{\omega r}{\alpha}\right) J_0(\lambda_n e) Y_0(\lambda_n r)\, dr \qquad (4c)$$

$$L_3 = \int_e^a r\, \bar{k}_2 J_0\left(\frac{\omega r}{\alpha}\right) Y_0(\lambda_n e) J_0(\lambda_n r)\, dr \qquad (4d)$$

$$L_4 = \int_e^a r\, \bar{k}_2 J_0\left(\frac{\omega r}{\alpha}\right) J_0(\lambda_n e) Y_0(\lambda_n r)\, dr \qquad (4e)$$

$$\bar{k}_1 = \omega A J_0(\omega e/\alpha)/b_0 \qquad (4f)$$

$$\bar{k}_2 = \omega A Y_0(\omega e/\alpha)/b_0 \qquad (4g)$$

$$b_0 = J_0(\omega e/\alpha) Y_0(\omega a/\alpha) - Y_0(\omega e/\alpha) J_0(\omega a/\alpha) \qquad (4h)$$

provided $\lambda_n \neq \omega/\alpha$. When $\lambda_n = \omega/\alpha = \beta$, we obtain[4]

$$A_\beta = \frac{\Pi^2 J_0(\beta e)[L_{1\beta} - L_{2\beta} - L_{3\beta} + L_{4\beta}]}{2\alpha[J_0^2(\beta e)/J_0^2(\beta_a) - 1]} \qquad (5a)$$

where

$$L_{1\beta} = \bar{k}_1\ Y_0(\beta e) \int_e^a J_0(\beta r) Y_0(\beta r) r\, dr \qquad (5b)$$

$$L_{2\beta} = \bar{k}_1\ J_0(\beta e) \int_e^a Y_0(\beta r) Y_0(\beta r) r\, dr \qquad (5c)$$

$$L_{3\beta} = \bar{k}_2\ Y_0(\beta e) \int_e^a J_0(\beta r) J_0(\beta r) r\, dr \qquad (5d)$$

$$L_{4\beta} = \bar{k}_2\ Y_0(\beta e) \int_e^a Y_0(\beta r) J_0(\beta r) r\, dr \qquad (5e)$$

From Eqs. (3) and (4), we compute the values of λ_n and A_n for various values of n in Table 1. We note that the amplitudes A_n drop off sharply at high frequencies. The ratios of the frequencies are taken to cancel the effects of the scale factors (see Table 2).

Conclusions

The eigenfrequencies generated by the simple model compare favorably with the frequencies of the complex finite element model. Moreover, this analysis produces the amplitudes of the vibrating modes. These eigenfrequencies and eigenmodes could be used to study the dynamics and control system design of the hoop-column antenna as a flexible body.

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Errata

Finite Element Method for Optimal Guidance of an Advanced Launch Vehicle

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THE position descriptions for the authors of this paper were incorrectly identified. The AIAA Editorial Staff regrets this error and any inconvenience it has caused our readers. The correct information appears below:

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