conditions, which in some cases do not vanish, but instead lead to a limit cycle behavior. This is especially true at the parameter points on the transition curves separating stability from instability in which periodic motions are predominant.

5. CONCLUDING REMARKS

The stability analysis of the pantograph–catenary system based on Hill's method of infinite determinant clearly reveals additional unstable areas at lower values of r not mentioned in references [1, 2]. The new parameter plane depicting transition curves separating stability from instability is validated using the free dynamic response results. We also pointed out the misapplication of the Floquet theory to the damped Mathieu equation resulting in less conservative solutions and missing instability regions. Furthermore, the analytical solution for the steady state forced response derived from the straightforward perturbation method is shown to be limited to only small values of α. Finally, we think these reported discrepancies do not actually alter the main conclusions of the earlier study [1, 2], but it does provide a more complete characterization of the stability behavior and points out an obvious misapplication of the Floquet theory.

REFERENCES

1. T. X. Wu and M. J. Brennan 1999 *Journal of Sound and Vibration* **219**, 483–502. Dynamic stiffness of a railway overhead wire system and its effect on pantograph–catenary system dynamics.
2. T. X. Wu and M. J. Brennan 1998 *Vehicle System Dynamics* **30**, 443–456. Basic analytical study of pantograph-catenery system dynamics.
3. A. Nayfeh and D. T. Mook 1979 *Nonlinear Oscillations*. New York: John Wiley & Sons.
4. L. Meirovitch 1970 *Methods of Analytical Dynamics*. New York: Mc-Graw Hill.

AUTHORS' REPLY

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REFERENCES

1. Y. GUAN and T. C. LIM 2001 *Journal of Sound and Vibration* **247**, 527–535. Comments on the stability analysis of pantograph-catenary system dynamics.
2. T. X. WU and M. J. BRENNAN 1999 *Journal of Sound and Vibration* **219**, 483–502. Dynamic stiffness of a railway overhead wire system and its effect on pantograph-catenary system dynamics.
3. T. X. WU and M. J. BRENNAN 1998 *Vehicle System Dynamics* **30**, 443–456. Basic analytical study of pantograph-catenary system dynamics.