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LETTERS TO THE EDITOR

COMMENTS ON "AN EXACT SOLUTION FOR A SIMPLIFIED MODEL OF THE HEAVE AND PITCH MOTIONS OF A SHIP HULL DUE TO A MOVING LOAD AND A COMPARISON WITH SOME EXPERIMENTAL RESULTS"

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1. INTRODUCTION

The coupled heave and pitch motions of a ship due to a moving load have been discussed in an article [1]. The load has been assumed to be a constant force moving at a constant speed. The proposed "exact solution" has been obtained through the application of the property of orthogonality of modal shapes and Duhamel integral. While the development is interesting, it seems that the proposed solution is not "exact" and the property of orthogonality of modal shapes has not been implemented properly. The results obtained from the proposed solutions in reference [1] are not compatible with the experimental ones. The proposed method of performing the experiments in reference [1] is not consistent with the applied theory.

2. ANALYSIS

In reference [1], first the modal matrix for the undamped system of equations of motion has been obtained. Next, this matrix has been applied in order to decouple equation (8) and to derive equation (23) of the paper. These equations are to be valid for the case of damped vibrations and equation (23) is the fundamental equation treated in reference [1]. The main purpose of performing this transformation has been to decouple the equations of motion. Clearly, in order to decouple the two equations of motion and find equations (23), the damping matrix must be diagonalized. Unfortunately, the modal matrix of the undamped system, while it can efficiently diagonalize the stiffness and the mass matrices, cannot, in general, diagonalize the damping matrix C as well. The damping matrix can be diagonalized only in some special cases like that of proportional damping [2]. It may thus be concluded that the solutions in reference [1] are not generally exact.

Another query arises when considering that for the experimental verification of the theoretical results, the magnitude of the moving force should be set constant

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during the experiment (as has been assumed in the theoretical part of reference [1]). Some details of the experimental set-up have been discussed in reference [1]. It seems that a moving weight has been implemented as the moving load. This would not ensure a complete analogy since the contact force of the load and ship model would not be constant during the load movement. In fact, parameters like the heave and pitch motions of the model, the position of the moving load at each instant together with its speed and relative mass all can be very influential in the value of the contact force between the load and the ship model. Hence, such a test would be a good means of comparison, only if the equations of motion are written for a moving mass and not a constant force.

Finally, the very poor agreement observed between theoretical and experimental results which are presented in Figures 19–21 of reference [1] should be mentioned. This problem might have occurred as a result of the foregoing considerations.

3. CONCLUSIONS

The modal matrix which is obtained through a free vibration analysis cannot in general be exactly applied to decouple a system of equations of motion with damping. Therefore, the results obtained through such an analysis cannot be indicated as exact, except for some special cases like proportional damping. Furthermore, the constant force assumption in the theoretical analysis seems to be incompatible with the manner that the experiments have been performed. This is due to the variation of the contact force during motion. It is believed that some of these considerations are responsible for the poor agreement observed in reference [1] between theoretical and experimental results.

REFERENCES

1. J.-S. Wu and J.-J. Sheu 1996 *Journal of Sound and Vibration* **192**, 495–520. An exact solution for a simplified model of the heave and pitch motions of a ship due to a moving load and a comparison with some experimental results.
2. L. Meirovitch 1986 *Elements of Vibration Analysis*. New York: McGraw-Hill, Second Edition.

AUTHOR'S REPLY

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I am very grateful to Drs. Arianpour and Ghorashi for thier comments on the paper entitled "An exact solution for a simplified model of the heave and pitch motions of

a ship hull due to a moving load and a comparison with some experimental results", by J.J. Sheu and myself.

I think both their comments and the theory of our paper should be all right. The difference is only the viewpoint. From the statements made on the final two lines on page 499 and the first paragraph on page 500 of our paper, it is evident that the exact solution (based on the assumed damping ratios) presented in our paper will be correct. Besides, as an experimental result involves a lot of factors, it seems unreasonable to say that a theoretical result is not correct because it is not close to the experimental result. I agree that one should pay attention during experiments to the points mentioned in the comments.