

**STUDY OF SMALL DISTURBANCE WAVES ACROSS ALTERNATE
RIGID AND COMPLIANT PANELS, WITH ANALYTICAL
JUMP CONDITIONS AT THE JUNCTIONS**

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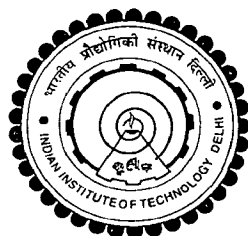
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**Submitted
in fulfilment of the requirements of the degree of**

Doctor of Philosophy

to the

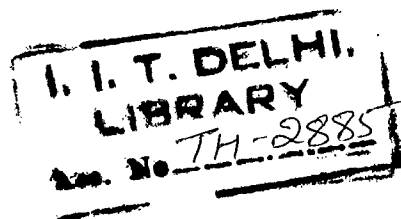
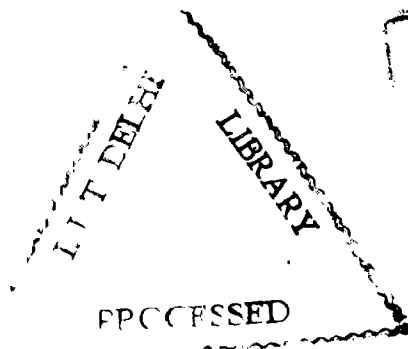


**Department of Applied Mechanics
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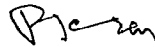
Wave mechanics;
wall finis;



To my parents and my teachers.

C E R T I F I C A T E

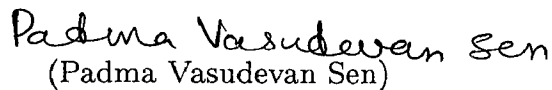
This is to certify that the thesis entitled "**Study of Small Disturbance Waves Across Alternate Rigid and Compliant Panels, with Analytical Jump Conditions at Junctions**" being submitted by **Mr. Shriram Hegde** for the award of the degree of Doctor of Philosophy, to the **Indian Institute of Technology, Delhi** is a record of bonafide work carried out by him under our guidance and supervision. The material embodied in this thesis, unless acknowledged otherwise, has not been submitted in part or in full for any other Diploma or Degree of any University.



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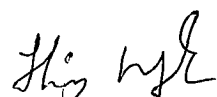
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(Shriram Hegde)

ABSTRACT

In this work the instability waves propagating in a channel flow across rigid and compliant wall joints are investigated. An analytical model based on half-Fourier transforms leading to a local vibrator model is developed to simulate the junction between the rigid and compliant walled sections. Extensive comparisons of results obtained by this methodology with those obtained from direct numerical simulations (DNS) of Davies and Carpenter (JFM 1997) are made. The agreement between the two sets of results is excellent.

The question of rigid and compliant junction arises where alternate rigid and compliant panels are used to consider a possible means of suppressing instabilities in viscous fluid flow. The local vibrator theory for the rigid and compliant junction developed herein is a generic methodology for a class of problems where two dissimilar wave bearing media form a junction. The present model is demonstrated by studying the developing patterns of Tollmien-Schlichting waves in a channel flow across rigid and compliant junctions. It is shown in this thesis that by calculating the jump in the amplitude of propagating TS waves across the junction, one can generate the spatial evolution pattern of the wave along the streamwise length of the panel. This actually amounts to linking the eigensolutions on the two sides of the junction by a mathematically compatible junction model.

The technique used to obtain the eigensolutions on the rigid and compliant walls is based on Sen and Arora method. The solution of the initial value problem ensuing from the local vibrator model, is based on the adjoint method, which is a novel approach for this class of problems. The results are obtained for various cases of TS waves below cutoff frequency and compared with those published by Davies and Carpenter(JFM 1997). More detailed study of wall modes is presented in the case of TS wave above the cutoff frequency also. Here too the results match very convincingly.

It is hoped that this work will help to solve many interesting problems relating to the compliant surfaces by achieving enormous reduction in computational efforts required in obtaining the solutions, as compared to DNS. As compared to direct numerical simulation methods therefor this technique results in far far greater economy

of computation. Also, it is hoped that this methodology will help to model problems where wall properties vary continuously, or, wave propagation taking place across junctions between different wall compliance on either side and many more problems of similar nature, in future.

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