Machine Tool Chatter: Effect of Surface Slope of Machining Forces During Wave Removing

W. B. Rice.\textsuperscript{2} The authors are to be congratulated on an interesting and provocative paper.

Referring to Fig. 7, for a given value of $\alpha$ and $\gamma$, was $\phi$ constant over a range of values $t$? In other words, was the angle $\theta$ constant along the chip as indicated in Fig. 6, within the range $t = 0.010$ to 0.025 in.?

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Authors' Closure

Yes, it was found that the strain angle $\theta$, and therefore the shear angle $\phi$, was constant for a given value of rake angle $\alpha$ and work surface slope $\gamma$ over the range of chip thicknesses indicated in the paper. It was also found that measurements taken out of this range were affected by size and deformation factors depending on the specimen dimension and composition.

Critical Reynolds Number Estimates by Thermodynamic (Stochastic) Methods\textsuperscript{1}

L. Schmerzler.\textsuperscript{2} The authors applied methods of irreversible thermodynamics to an unsolved problem and obtained results for both the critical Reynolds number and the point of instability, which fit well experimental data and are not inconsistent with results based on the solutions of the Orr-Sommerfeld equations. This applies, of course, only to the cases where such results are available.

The extremum properties of entropy production can be obtained in principle from even more fundamental equations than the Navier-Stokes equations—namely, from the integro-differential Boltzmann equation—through essentially straightforward applications of variational principles to the kinetic theory.

Additional Reference


Authors' Closure

The problem of transition is a very difficult one in even the simplest geometries. We feel, therefore, that a whole gamut of methods should be applied in the analysis of transition, like deterministic and nondeterministic methods, variational principle approach, as well as purely numerical "brute force" methods. This multi-pronged way of attacking the problem should eventually shed new light on the exact mechanism of transition that, so far, seemed to have eluded many investigators.

ERRATA


1 Title change Thermo-Dynamic to Thermodynamic

2 Page 788, line 6 from top: change whereby to where by

3 Page 790, left column, line 24 from bottom: change $Re_{c,t}$ to $Re_{c,t,i}$

4 Page 790, equation (3):

$$\alpha u_{w}^{2}\nabla^{2} + \mu\frac{\partial u}{\partial y}$$

change to $\mu\frac{\partial u}{\partial y}$

5 Page 792, right column, line 17 from top: change $f_1$ to $f_1$

6 Page 792, right column, line 5 from bottom: change faster than $\phi$, to faster than $\alpha u_{w}^{2}$

7 Page 793, left column, line 13 from top: change 0.225 to 0.0225

8 Page 794, reference [23]: change 388-401 to 397-401

9 Page 793, Table 2, to read as follows:

<table>
<thead>
<tr>
<th>Geometry</th>
<th>Calculated $Re_{c,t}$</th>
<th>Observed Lower $Re_{c,t}$</th>
<th>$\theta$</th>
<th>Calculated Upper $Re_{c,t}$</th>
<th>Observed Upper $Re_{c,t}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat Plain $150$ (Re$_{c,t}$ $\approx$ $8600$)</td>
<td>$4 \times 10^{4}$</td>
<td>$3 \times 10^{4}$</td>
<td>3.6 $2 \times 10^{4}$</td>
<td>2.6 $4 \times 10^{4}$</td>
<td></td>
</tr>
<tr>
<td>Pipe $1200-1400$</td>
<td>$1900-2100$</td>
<td>$1500$</td>
<td>1.5 $2 \times 10^{4}$</td>
<td>1.6 $4 \times 10^{4}$</td>
<td></td>
</tr>
<tr>
<td>Channel $70/100$</td>
<td>$1600-1800$</td>
<td>$1500-1800$</td>
<td>1.2 $2 \times 10^{4}$</td>
<td>$2 \times 10^{4}$</td>
<td></td>
</tr>
<tr>
<td>Annex. Jet $70$</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td></td>
</tr>
<tr>
<td>Pipe Jet $146.5$</td>
<td>30</td>
<td>10</td>
<td>1.0</td>
<td>1000</td>
<td></td>
</tr>
</tbody>
</table>

Design of Multi-Recess Hydrostatic Journal Bearings for Minimum Total Power Loss

B. C. Majumdar.\textsuperscript{2} The authors have presented a simplified design method of multi-recess externally pressurized oil journal bearings with rotating journal for minimum power consumption. The discusser, however, feels that the authors solved the problem with too many simplifying assumptions for the rotating journal and wishes to make the following comments.

1 Ignoring the pressure due to rotation, i.e., the cavitation effect (which does not allow the use of simple superposition principle of continuity equation), the complexity of the problem, on one hand.

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hand, has been avoided. And on the other hand, the resulting load (which is responsible for pressures in the recesses (equation (22)) given in Fig. 4 is almost independent of journal speed. The first term of the right-hand side of equation (28) which contributes a part of the total power loss will also be nearly independent of journal speed. Hence recess pressures could be calculated with $a = 0$ (i.e., with a purely hydrostatic case) saving some computer time for the iteration method used to determine $a$.

2 Equations (1) and (2) are iterated to obtain the recess pressures. If the condition in equation (2), ($p_2 = p_4$), is used, three simultaneous algebraic equations will result instead of four, as the authors solved.

3 As the discusser has an experience in tackling a very similar problem in a more rigorous way, the assumption 5 at high $\epsilon$ ($0.6 < \epsilon < 0.8$) is not true. Perhaps the authors could have verified their approximate analysis with that of Heller, et al. (reference [7]) to see the quantitative error.

Authors' Closure

The authors wish to thank Professor Majumdar for his discussion. He made three specific comments about the formulation, solution, and results of the problem analyzed in the paper. We will respond to each of these comments.

The effect of journal rotation on the recess pressure was not ignored. It was assumed, however, that the hydrodynamic effects were negligible and that the circumferential flow over $l_c$ was only due to the pressure difference between adjacent recesses and the shearing action of the journal (velocity induced flow). The contribution of this "velocity induced flow" is represented by the $\omega$ term in equations (11) and (12) of the paper. In the analysis presented in the paper, cavitation is assumed to occur when one of the recess pressures becomes negative (for the loading configuration given in Fig. 1 of the paper, recess number one would first experience a negative pressure). Cavitation, as defined above, occurs at relatively high values of speed parameter $\omega$. The data for such speed parameters are not presented in the paper.

The load variable data presented in Fig. 4 of the paper are the load variables at the optimum design. These data indicate that the load variable is almost independent of speed over the range analyzed. However, for a fixed geometry the load variable is not independent of the journal speed. The attitude angle, $\alpha$, at the optimum design is not near zero except at speeds near zero. For an $\omega$ of 32, for example, $\alpha$ approaches an angle of one radian.

In the paper, the five equations, equations (1) and (2), were solved simultaneously for $P_1$, $P_2$, $P_3$, $P_4$, and $\alpha$. If equation (2) were to be substituted in equations (1), there would be four equations for the four unknowns $P_1$, $P_2$, $P_3$, and $\alpha$. We feel that this reduction in the number of equations would not significantly reduce the computational cost because most of the computational time is used in the optimization portion of the program and not in the simultaneous solution of equations (1) and (2).

The authors agree in principle with Professor Majumdar that if the conditions of assumption five are not held, the results presented in the paper would be in error for high values of eccentricity. The results presented show that the optimum value of $\beta$, the inter-recess land angle, is in the order of 7–19 deg for the bearing configuration considered. Fig. 12 in the paper shows that the maximum length of the inter-recess lands is approximately one-fourth of the circumferential length of the recesses for an eccentricity ratio of 0.20. For higher eccentricity ratios, the optimum values of inter-recess land lengths are lower. For these geometries, we feel that the results presented are adequate for most applications.

The approximate analysis used in the paper could not be verified with more rigorous analyses because, to our knowledge, data obtained from rigorous analyses are either not available for the bearing geometry considered or they are presented in such a form which makes them difficult to use for comparison purposes. Davis [3] has stated, however, that analytical data obtained from an approximate analysis similar to the one used by the authors compared extremely well with experimental findings.

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