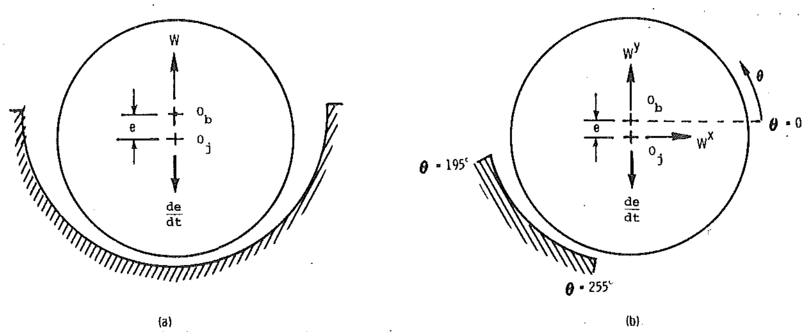

Fig. 1 Journal and partial arc bearing configurations

Table 5 Effect of mesh size on $\overline{W}_A$ and $\overline{W}_{ASY}$*

Number of Mesh points N	$\overline{W}_A$	$\overline{W}_{ASY}$
10	213.158	499.471
20	208.680	508.539
40	207.891	511.834
50	207.784	512.213
80	207.636	512.563

* Results are for a centrally loaded squeeze journal bearing (π), $L/D = 0.5$, $\epsilon = 0.9$, $\overline{W}_E = 209.619$.

It is interesting to note that the errors[8] in the new approximations (in particular $\overline{W}_A$) are quite small as shown in Tables 3 and 4 ranging from a fraction of a percent at small L/D and ϵ to about 7 percent at $L/D = 2$ and $\epsilon = 0.9$. Also shown in Table 3 are results obtained using the classical short bearing solution. The present approximations are far better. For example at $L/D = 0.5$ and $\epsilon = 0.9$, the approximation $\overline{W}_A$ differs by only 0.9 percent from the true solution whereas the short bearing solution differs by 150 percent.

Finally, Table 5 shows the effect of mesh size on $\overline{W}_A$ and $\overline{W}_{ASY}$ for a fairly severe case ($L/D = 0.5$, $\epsilon = 0.9$, 'π' squeeze film). Although the results presented in this paper are for $N = 50$,[9] we can clearly see that $N = 20$ would probably suffice for most engineering computations.

Conclusions

In this note, novel generalized short bearing solutions have been presented. Several examples have been given to illustrate the utility of these solutions. Essentially, the method proposed yields an accurate solution to the Reynolds equation for finite bearings through the integration of one ordinary differential equation. In addition, an approximate solution to this ordinary differential equation via singular perturbation theory was presented. Although future work in this area may lead to more accurate (e.g., higher order) matched expansions, the authors feel that from a practical point of view such efforts may not lead to significant gains over the straightforward integration of (6). An alternative, and possibly more fruitful, approach is to assume a different axial pressure distribution.

[8] The results presented in Table 3 were obtained from a series solution of Reynolds equation similar to [9] whereas those in Table 4 were obtained by finite difference methods. In the latter case, a 60 × 30 mesh was used for $L/D \leq 0.5$ and a 60 × 60 for $L/D > 0.5$.

[9] The mesh size is then 1 or $(\theta_2 - \theta_1)$ divided by N.

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DISCUSSION

I. Etsion[10]

This paper is an important addition to the literature on hydrodynamic lubrication. It eliminates the shortcoming of Ocvirk's approximation which dictates pressures at $x = 0$ and $x = 1$ according to the values of $b(x)$ and $a(x)$ at these boundaries. A similar approach based on singular perturbation was already used elsewhere [12] to generate solutions to the Reynolds equation which satisfy inlet and outlet pressure conditions in short bearings of aribtrary film thickness $h(x)$. However, it was found that using matched asymptotics and boundary layers alone limits the approximation to small values of the ratio B/L. The authors overcome this difficulty by combining variational and singular perturbation methods and they deserve commendation.

An important result of the present analysis should be pointed out with regard to the load carrying capacity of slider bearings. For incompressible isoviscous cases the terms $a(x)$ and $b(x)$ are related to $h^3(x)$ and dh/dx, respectively. Hence, the integral in equation (20) depends only on $h(1)$ and $h(0)$ regardless of the actual function $h(x)$ in the region $1 > x > 0$. As a result the load $\overline{W}$ is completely determined by the clearances and slopes at the inlet and outlet of the bearing. This interesting result which was also found in [12] confirms a fact that was previously established only by experience.

[10] Department of Mechanical Engineering, Technion, Haifa, Israel.

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J. F. Booker[11]

Always welcome are easily computable closed-form solutions (approximations) *not* suffering the boundary condition limitations of the short bearing solution. It is disappointing, therefore, that the attractive asymptotic solution (15) is no more accurate than it seems. However, the simple finite difference solution of the 1-dimensional equation (10) looks like a big step forward, even though it lacks the elegance of a closed-form solution.

Based on the authors' description of their procedure, we have verified the partial arc bearing results in Tables 3 and 4. The procedure seems to be numerically reliable (in both single and double precision computations on the IBM 370/168) and provides advantages of accuracy over available closed-form approximations and efficiency over available 2-dimensional finite element and finite difference procedures.

The authors have added something of value to our collection of basic tools, especially for applications involving dynamics and/or optimization.

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Bibliographic Note:

13 Readers should be aware that the complementary work [2] has been reported at the present Conference for publication in this Journal [14].

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Authors' Closure

The authors wish to thank Professor Etsion and Professor Booker for their comments. As both discussors indicate, results obtained using asymptotics were not as good as hoped for except for small L/D or ϵ—the slider inclination studied being equivalent to a small value of ϵ. Perhaps one should consider higher order approximations. We look forward to Professor Etsion's paper [12] appearing in the open literature. On the other hand, as indicated, the finite difference equation method is easy to implement and rapid. In fact, these approximations were motivated by the desire to solve a class of dynamically loaded bearing problems rapidly.