HYDRODYNAMIC LUBRICATION THEORY FOR AN EXACT BINGHAM PLASTIC FLUID MODEL

Stefan G.E. Lampaert [a*], Ron A.J. van Ostayen [a]
* S.G.E.Lampaert@tudelft.nl
[a] Delft University of Technology,
Mekelweg 2, Delft, The Netherlands

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ABSTRACT
Grease is an important lubricant in modern tribological systems, yet modelling of these fluids in thin lubricating films is hard due to the discontinuities in the rheological properties caused by the yield stress. A good method to model this behaviour is especially relevant in the design of bearings using Magneto- or Electrorheological fluids.

In [1], [2] an approximation of the lubrication theory of a Bingham plastic was presented based on a regularization technique (Bingham-Papanastasiou) to take care of the discontinuity. This method is a numerical approximation and relatively slow.

The method presented in this work does not require this regularization technique, and thus uses the exact Bingham Plastic rheological model. This makes the method fully analytical and therefore relatively fast. The method furthermore starts with an assumed surface stress value, which is iteratively modified to match the given surface velocity.

Figure 2 and Figure 1 show the resulting flow fields for both a full numerical approximation (double Riemann integral of stress distribution) , the numerical approximation presented by [2] and the analytical method presented in this work. The results show that the different methods are in good accordance.

The analytical integration of this flow field gives the flow rate. A pressure distribution is achieved by solving for the pressure, using conservation of mass, similar to the classic Reynolds equation approach.

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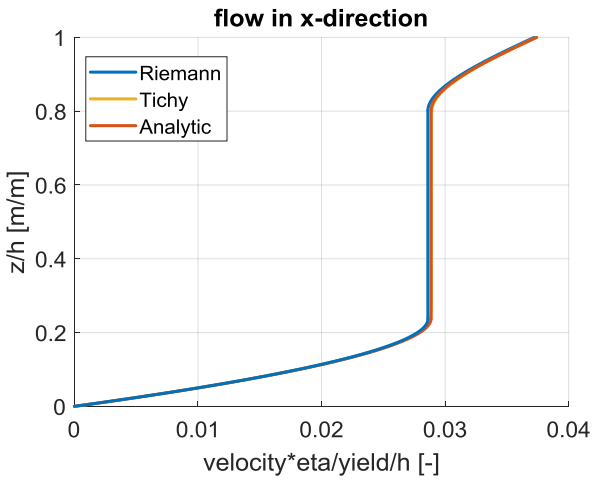

Figure 1 : Typical flow field in x-direction for a Bingham fluid with the use of different methods.

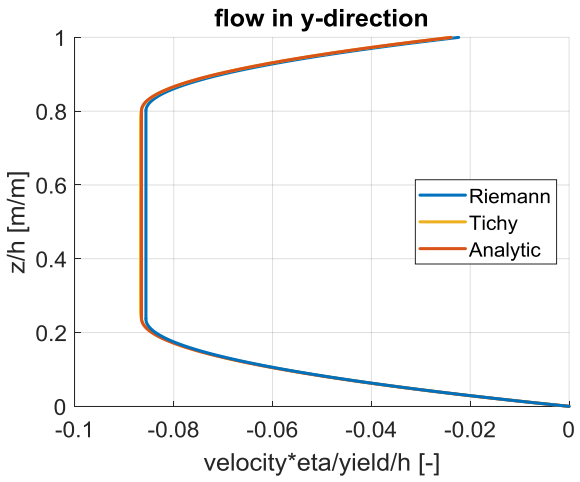

Figure 2 Typical flow field in y-direction for a Bingham fluid with the use of different methods.