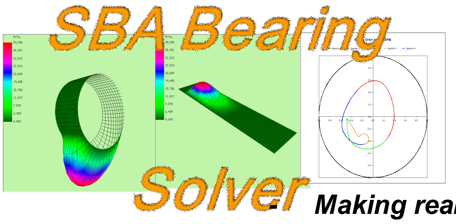
SBA bearing solver



Data Sheet

- Making real life easier

V2016-02-01

History of oil lubricated bearings

The first person to understand oil lubricated bearings was Beauchamp Towers in 1879 whilst carrying out tests on rail rolling stock axle bearings. He discovered that placing a bung over the oil feedhole caused the bung to be pushed out and he postulated this was due to pressure being exerted by oil reacting the weight of the axle. Further tests proved him correct in 1884.

Reynolds 1886 was the first person to derive a theory that described the physics of the oil film and proposed the Reynolds equation of hydrodynamic lubrication.

It did not have a solution until Sommerfeld 1904 proposed a solution for the infinitely long bearing. L/D >> 2.0

Michell 1929 and Cardullo 1930 first proposed solutions for the short bearing applied to sliding pad bearings.

Cameron and Wood 1949 used the relaxation method developed by Southwell 1946 to carry out calculations on the full journal bearing.

Ocvirk and Dubois 1953 proposed the short bearing solution. L/D < 1.0

Then in 1957 Jacob, Olson and Floberg proposed a numerical solution including the cavitated oil film for the finite bearing.

Reason and Narang 1981 proposed an analytical combination of the short and long bearing which approximates the accuracy of numerical solution RHD for plain journal bearings.

Reason and Siew 1983 proposed a numerical solution of the finite bearing with misalignment

Since that time many workers have proposed many types of numerical solution including the RHD, EHD and TEHD methods.

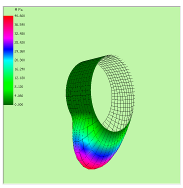
Short bearing approximation – SBA

SBA Short **B**earing **A**pproximation after Ocvirk and Michell for eccentricity ratios of 0 – 0.3, includes squeeze terms in solver but no squeeze shown here as is the IPR of AIES. The squeeze terms are required for transient and shock modelling.

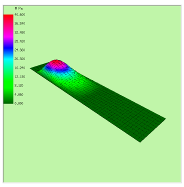
$$P = \frac{3.\eta.U}{R.C^2}.\left(\frac{L^2}{4} - y^2\right).\frac{\varepsilon.\sin\theta}{(1+\varepsilon.\cos\theta)^3}$$

Short bearing approximation – SBA results

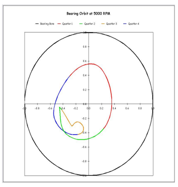
The short bearing is applicable for eccentricities of 0-0.3 and plain bearings. The figures below show 3-D and Isometric pressure profile for a π- cavitated bearing at 5,000 rpm. RHS Figure shows its orbit. Note that this solution can approximate the effect of a circumferential groove, but cannot determine the effects of short or randomly positioned grooves and oil holes in the bearing shell or a moving oil hole in the journal.



SBA 3D Pressure profile



SBA Isometric Pressure profile



SBA Bearing Orbit

Transient solvers – many applications

- Runge Kutta Cash Karp
- Newmark Beta
- Bulirsch Stoer
- Others are under development
- Can be used in conjunction with
  - Other solvers
  - MBD
  - Rotor Dynamics

Bearing applications - AIES Tribology solvers

Solvers can be used for simulating

- Dynamically loaded Engine bearings,
- Steady loaded bearings
- Instability of bearings
- Unbalance response of bearings
- Forced response over a speed sweep (range) including blade excitation
- Transient shock response of bearings

Simulating any shape of bearing using a Profile function

- Hence can simulate
- Assembled
- Manufactured
- Worn shape
- Offset halves, lemon and pressure dammed etc.

Any type of loading

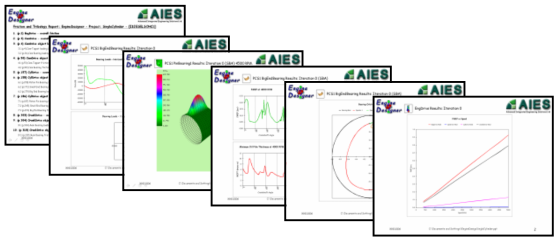
- Gravity, Steady& unbalance
- Any transient load history (load against angle)
- Harmonic and Fourier loads

Solvers can also be used to generate

- Stiffness and Damping coefficients of bearings
  - With SBA, SALBA and RHD
- Any shape of bearing using Profile feature
  - Hence simulate Assembled, manufactured and worn shapes

System design report

- MS PowerPoint format



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