Appendix - A1

NON CIRCULAR BEARING GEOMETRY

The non circular (two-lobe, three lobe) bearing geometries are as follows.

A 1.1 Two-Lobe Bearing

The two lobe bearing consists of two circular halves with centers O_1 and O_2 (Fig. A 1.1) with offset ε_p on either side of the geometric centre O_b of the bearing. The eccentricities ε_1 and ε_2 and attitude angles ϕ_1 and ϕ_2 for any journal centre O_3 can be calculated by using the following equations.

For lower lobe:

$$\varepsilon_1 = \left\{\varepsilon^2 + \varepsilon_p^2 + 2\varepsilon\varepsilon_p \cos\phi\right\}^{1/2} \quad \text{(A 1.1)}$$

$$\phi_1 = \tan^{-1}\left\{\frac{\varepsilon \sin\phi}{\varepsilon_p + \varepsilon\cos\phi}\right\} \quad \text{(A 1.2)}$$

For upper lobe:

$$\varepsilon_1 = \left\{\varepsilon^2 + \varepsilon_p^2 - 2\varepsilon\varepsilon_p \cos\phi\right\}^{1/2} \quad \text{(A 1.3)}$$

$$\phi_2 = \pi - \tan^{-1}\left\{\frac{\varepsilon \sin\phi}{\varepsilon_p + \varepsilon\cos\phi}\right\} \quad \text{(A 1.4)}$$

A 1.2 Three-Lobe Bearing

The three lobe bearing consists of three non concentric arcs Fig. A 1.2 and the various geometric parameters of a three lobe bearing are related as follows.

Lobe 1:

$$\varepsilon_1 = \left\{\varepsilon^2 + \varepsilon_p^2 + 2\varepsilon\varepsilon_p \cos\phi\right\}^{1/2} \quad \text{(A 1.5)}$$

$$\phi_1 = \tan^{-1}\left\{\frac{\varepsilon \sin\phi}{\varepsilon_p + \varepsilon\cos\phi}\right\} \quad \text{(A 1.6)}$$

Lobe 2:

$$\varepsilon_1 = \left\{ \varepsilon^2 + \varepsilon_p^2 - 2\varepsilon\varepsilon_p \cos\left(\frac{\pi}{3} + \phi \right) \right\}^{1/2} \tag{A 1.7}$$

$$\phi_2 = \frac{2\pi}{3} - \tan^{-1}\left\{ \frac{\varepsilon \sin\left(\frac{\pi}{3} + \phi \right)}{\varepsilon_p - \varepsilon \cos\left(\frac{\pi}{3} + \phi \right)} \right\} \tag{A 1.8}$$

Lobe 3:

$$\varepsilon_1 = \left\{ \varepsilon^2 + \varepsilon_p^2 - 2\varepsilon\varepsilon_p \cos\left(\frac{\pi}{3} - \phi \right) \right\}^{1/2} \tag{A 1.9}$$

$$\phi_2 = \frac{2\pi}{3} - \tan^{-1}\left\{ \frac{\varepsilon \sin\left(\frac{\pi}{3} - \phi \right)}{\varepsilon_p - \varepsilon \cos\left(\frac{\pi}{3} - \phi \right)} \right\} \tag{A 1.10}$$

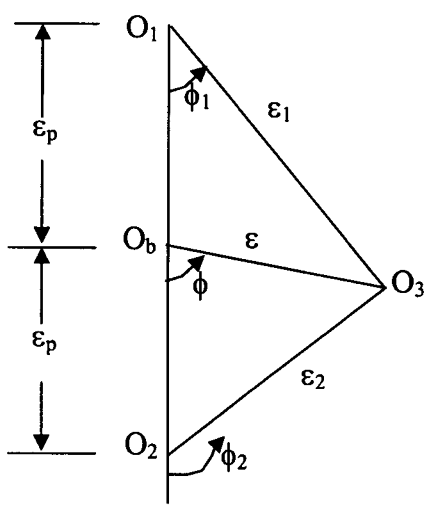

Fig. A 1.1 Geometry of two lobe bearing

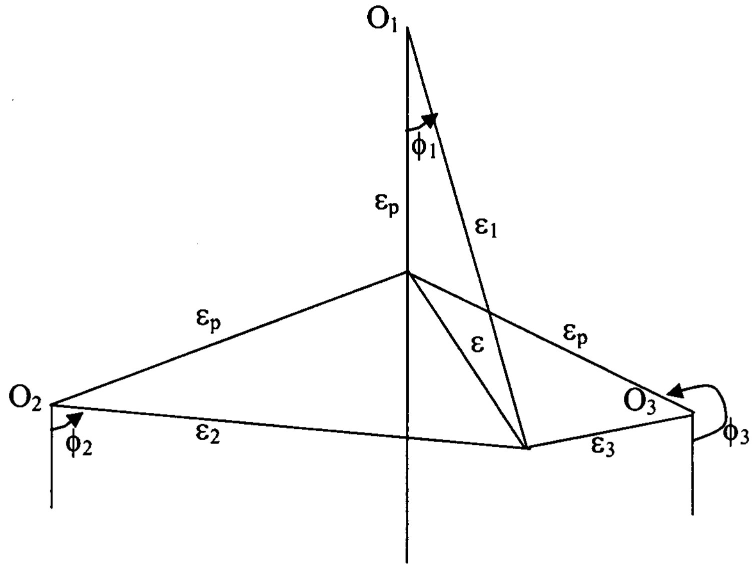

Fig. A 1.2 Geometry of three lobe bearing

Appendix-A2

THE TRANSFORMATION OF STIFFNESS AND DAMPING COEFFICIENTS

The fluid film damping forces which depend on velocities $\dot{\xi}$ and $\dot{\eta}$ are given by its horizontal and vertical components and these components can be written as shown below.

$$W_1 = -(b_{1\xi}\,\dot{\xi} + b_{1\eta}\,\dot{\eta}) \tag{A 2.1}$$

$$W_2 = -(b_{2\xi}\,\dot{\xi} + b_{2\eta}\,\dot{\eta}) \tag{A 2.2}$$

Equations A 2.1 and A 2.2 can be written in matrix form as

$$\begin{bmatrix} W_{1} \\ \\ W_2 \end{bmatrix} = \begin{bmatrix} b_{1\xi}/\varepsilon & b_{1\eta} \\ \\ b_{2\xi}/\varepsilon & b_{2\eta} \end{bmatrix} \begin{bmatrix} \varepsilon\dot{\xi} \\ \\ \dot{\eta} \end{bmatrix} \tag{A 2.3}$$

ε, $\dot{\xi}$ and $\dot{\eta}$ can be written in terms of $\dot{x}_1$ and $\dot{x}_2$ as given below.

$$\begin{bmatrix} \varepsilon\dot{\xi} \\ \\ \dot{\eta} \end{bmatrix} = \begin{bmatrix} \cos\theta & -\sin\theta \\ \\ \sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} \dot{x}_1 \\ \\ \dot{x}_2 \end{bmatrix} \tag{A 2.4}$$

Thus equation A 2.3 can be written as

$$\begin{bmatrix} W_{1} \\ \\ W_2 \end{bmatrix} = \begin{bmatrix} b_{1\xi}/\varepsilon & b_{1\eta} \\ \\ b_{2\xi}/\varepsilon & b_{2\eta} \end{bmatrix} \begin{bmatrix} \cos\theta & -\sin\theta \\ \\ \sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} \dot{x}_1 \\ \\ \dot{x}_2 \end{bmatrix} \tag{A 2.5}$$

The fluid film damping force components can be written in terms of damping coefficients and velocities as given below.

$$\begin{bmatrix} W_1 \\ \\ W_2 \end{bmatrix} = \begin{bmatrix} B_{11} & B_{12} \\ \\ B_{21} & B_{22} \end{bmatrix} \begin{bmatrix} \dot{x}_1 \\ \\ \dot{x}_2 \end{bmatrix} \qquad \text{(A 2.6)}$$

Comparing equations A 2.5 and 2.6

$$\begin{bmatrix} B_{11} & B_{12} \\ \\ B_{21} & B_{22} \end{bmatrix} = \begin{bmatrix} b_{1\xi} & b_{1\eta} \\ \\ b_{2\xi} & b_{2\eta} \end{bmatrix} \begin{bmatrix} \dfrac{\cos\theta}{\varepsilon} & \dfrac{-\sin\theta}{\varepsilon} \\ \\ \sin\theta & \cos\theta \end{bmatrix} \qquad \text{(A 2.7)}$$

As the displacements and velocities are in the same direction similar transformation can be used for stiffness coefficients also.

$$\begin{bmatrix} S_{11} & S_{12} \\ \\ S_{21} & S_{22} \end{bmatrix} = \begin{bmatrix} s_{1\xi} & s_{1\eta} \\ \\ s_{2\xi} & s_{2\eta} \end{bmatrix} \begin{bmatrix} \dfrac{\cos\theta}{\varepsilon} & \dfrac{-\sin\theta}{\varepsilon} \\ \\ \sin\theta & \cos\theta \end{bmatrix} \qquad \text{(A 2.8)}$$