

Partially Textured Slider and Journal Bearing Analysis

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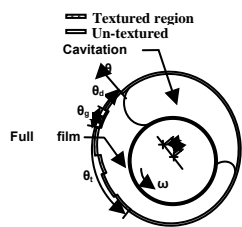
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Article history

Received :15 June 2012
Received in revised form :12 August 2012
Accepted :28 August 2012

Graphical abstract



Abstract

The present study examines the influence of partial texturing of bearing surfaces on improvement in load capacity and reduction in friction coefficient for slider and journal bearing. The geometry of partially textured slider and journal bearing considered in this work composed of a number of successive regions of groove and land configurations. The nondimensional pressure expressions for the partially textured slider and journal bearing are derived taking into consideration of texture geometry and extent of partial texture. Partial texturing has a potential to generate load carrying capacity and reduce coefficient of friction, even for nominally parallel bearing surfaces.

Keywords: Partial texture, slider bearing, journal bearing, load capacity, coefficient of friction

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1.0 INTRODUCTION

A growing interest is given to the partial texturing of bearing surfaces with different shapes of textures and at different locations since partial texturing is an effective approach to improve the performance of bearings. An important aspect in the analysis of textured hydrodynamic lubricated contacts is the understanding of lubricant film formation and its contribution to generation of hydrodynamic pressure and consequent friction reduction. An improvement in the hydrodynamic performance was achieved due to the texture in the converging gap of journal bearing (Cupillard et al., 2008).

Tønder (2001) studied the effect of introducing variable roughness profile at the inlet of a sliding surface contact and pointed out that higher load can be generated. Using theoretical studies on micro-dimples in parallel thrust bearings, Brizmer et al. (2003) provided a comparison of partially and fully textured surfaces and pointed out that partial texturing increase significantly the load capacity compared with full texturing. Cupillard et al. (2008) investigated the mechanism of pressure buildup due to the existence of textures in an inclined slider bearing. Fowell et al. (2007) derived analytical solution for pocketed convergent and parallel slider bearing. They have analyzed the effects of cavitation on bearing performance considering surface texture geometry such as texture depth, width, number of textures, and location of textures. Pascovici et al. (2009) have presented a theoretical investigation of nominally parallel partially textured sliders wherein the performance characteristics (load capacity, friction force, friction coefficient) are evaluated in terms of texture dimensions. They have presented optimum values of design parameters for maximum load carrying

capacity and minimum friction coefficient. Rahmani et al. (2010) introduced an analytical approach to study various texture profiles in hydrodynamic lubrication regime and presented optimum texturing parameters of maximum load capacity and minimum friction coefficient for partially textured slider bearings. Tala-Ighil et al. (2011) examined the cylindrical texture with different shapes/ locations on the hydrodynamic journal bearing performance and found that when the texture is located in the declining part of pressure field, partial texturing can generate hydrodynamic load capacity.

This work presents nondimensional pressure expressions for the (i) partially textured convergent slider bearing, (ii) partially textured parallel slider bearing, (iii) partially textured convergent journal bearing, and (iv) partially textured concentric journal bearing. Partial texturing is considered on the stationary surface of slider and journal bearing composed of a number of successive regions of groove and land. Reynolds boundary conditions are used to solve the pressure distribution in the journal bearing. Nondimensional load capacity and coefficient of friction in the partially textured slider and journal bearing under steady state are analyzed.

2.0 PARTIALLY TEXTURED SLIDER BEARING ANALYSIS

Figure 1 shows the schematic of partially textured slider bearing depicting the inception of partial texture composed of a number of successive regions of groove and land configurations. The length of successive regions of groove and land are

$X_{1,2} - X_{1,1} = \dots = X_{n,2} - X_{n,1} = X_g$ and $X_{1,3} - X_{1,2} = \dots = X_{n,3} - X_{n,2} = X_d$ respectively. The textured length is X_t . The specification of texture in slider bearing are: nondimensional texture length for slider bearing (X_t), nondimensional depth of groove (H_g), groove to texture region ratio (γ), number of grooves in the texture region (n). Partial texturing is an effective approach to improve the load capacity compared with full texturing (Brizmer et al., 2003).

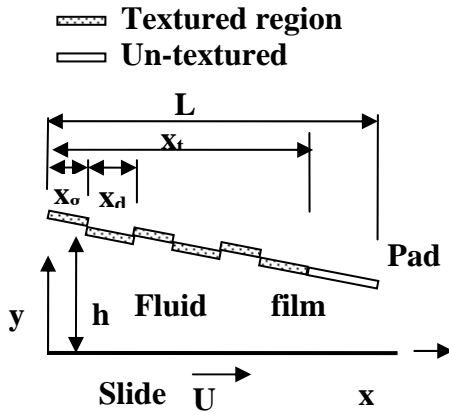


Figure 1 Geometry of partially textured slider bearing

2.1 Convergent Slider Bearing

The nondimensional film thickness in the groove region of partially textured slider bearing is expressed as $H + H_g$, where

H is the nondimensional film thickness for plain slider bearing expressed in Eq. (1) as

$$H = 1 - a_h X \text{ where } a_h = 1 - H_2 \tag{1}$$

The nondimensional flow through slider bearing is expressed as

$$Q = \frac{H}{2} - \frac{H^3}{12} \frac{dP}{dX} \tag{2}$$

The nondimensional shear stress in slider bearing is

$$\Pi|_{y=0} = \frac{H}{2} \frac{dP}{dX} + \frac{1}{H} = \left(\frac{4}{H} - \frac{6Q}{H^2} \right) \tag{3}$$

The boundary conditions for groove and land for region l respectively of partially textured slider bearing are

$$P|_{X=0} = 0, P|_{X=X_{1,2}} = P_{1,2} \text{ and } P|_{X=X_{1,3}} = P_{1,3} \tag{4}$$

Integrating the Eq. (2) and substituting the boundary conditions given in Eq. (4), results in nondimensional pressure profiles for groove and land for region l respectively as

$$P(0 \leq X \leq X_{1,2}) = P|_{X=0} + 6 \int_0^X \frac{1}{(H + H_g)^2} dX - 12Q \int_0^X \frac{1}{(H + H_g)^3} dX \tag{5}$$

$$P(X_{1,2} \leq X \leq X_{1,3}) = P|_{X=X_{1,2}} + 6 \int_{X_{1,2}}^X \frac{1}{H^2} dX - 12Q \int_{X_{1,2}}^X \frac{1}{H^3} dX \tag{6}$$

Similarly, the boundary conditions for groove and land region n respectively of partially textured slider bearing are

$$P|_{X=X_{n,1}} = P_{n-1,3}, P|_{X=X_{n,2}} = P_{n,2} \text{ and } P|_{X=X_{n,3}} = P_{n,3} \tag{7}$$

Integrating the Eq. (2) and substituting the boundary conditions given in Eq. (7), results in nondimensional pressure profiles for groove and land for region n respectively as

$$P(X_{n,1} \leq X \leq X_{n,2}) = P|_{X=X_{n,1,3}} + 6 \int_{X_{n,1}}^X \frac{1}{(H + H_g)^2} dX - 12Q \int_{X_{n,1}}^X \frac{1}{(H + H_g)^3} dX \tag{8}$$

$$P(X_{n,2} \leq X \leq X_{n,3}) = P|_{X=X_{n,2}} + 6 \int_{X_{n,2}}^X \frac{1}{H^2} dX - 12Q \int_{X_{n,2}}^X \frac{1}{H^3} dX \tag{9}$$

The boundary conditions for the exit region of partially textured slider bearing is

$$P|_{X=X_{n,3}} = P_{n,3}, P|_{X=1} = 0 \tag{10}$$

Integrating the Eq. (2) and substituting the boundary conditions given in Eq. (10), results in nondimensional pressure profile for the exit region as

$$P(X_{n,3} \leq X \leq 1) = P|_{X=X_{n,3}} + 6 \int_{X_{n,3}}^X \frac{1}{H^2} dX - 12Q \int_{X_{n,3}}^X \frac{1}{H^3} dX \tag{11}$$

Rearranging and simplifying the nondimensional pressure in Eqs. (5), (6), (8), (9) and (11) results in Q as

$$Q = \frac{\int_0^{X_{1,2}} \frac{1}{(H + H_g)^2} dX + \int_{X_{1,2}}^{X_{1,3}} \frac{1}{H^2} dX + \dots + \int_{X_{n,1}}^{X_{n,2}} \frac{1}{(H + H_g)^2} dX + \int_{X_{n,2}}^{X_{n,3}} \frac{1}{H^2} dX + \int_{X_{n,3}}^1 \frac{1}{H^2} dX}{\int_0^{X_{1,2}} \frac{2}{(H + H_g)^3} dX + \int_{X_{1,2}}^{X_{1,3}} \frac{2}{H^3} dX + \dots + \int_{X_{n,1}}^{X_{n,2}} \frac{2}{(H + H_g)^3} dX + \int_{X_{n,2}}^{X_{n,3}} \frac{2}{H^3} dX + \int_{X_{n,3}}^1 \frac{2}{H^3} dX} \tag{12}$$

The net load support of the bearing is obtained by integrating the nondimensional pressure as

$$W = \int_0^1 P dX \tag{13}$$

The nondimensional shear stress of groove and land region l is expressed as

$$\Pi(0 \leq X \leq X_{1,2}) = \frac{4}{(H + H_g)} - \frac{6Q}{(H + H_g)^2} \tag{14}$$

$$\Pi(X_{1,2} \leq X \leq X_{1,3}) = \frac{4}{H} - \frac{6Q}{H^2} \tag{15}$$

The nondimensional shear stress of groove and land region n is

$$\Pi(X_{n,1} \leq X \leq X_{n,2}) = \frac{4}{(H + H_g)} - \frac{6Q}{(H + H_g)^2} \quad (16)$$

$$\Pi(X_{n,2} \leq X \leq X_{n,3}) = \frac{4}{H} - \frac{6Q}{H^2} \quad (17)$$

The nondimensional shear stress for exit region is

$$\Pi(X_{n,3} \leq X \leq 1) = \frac{4}{H} - \frac{6Q}{H^2} \quad (18)$$

The nondimensional friction force is obtained by integrating the shear stress as

$$F = \int_0^1 \Pi dX \quad (19)$$

The nondimensional friction coefficient is calculated as

$$C_f = \left(\frac{L_s}{h_1} \right) \frac{f}{w} = \frac{F}{W}$$

2.2 Parallel Slider Bearing

The nondimensional pressure profiles for groove and land for region l respectively of a partially textured parallel slider bearing are

$$P(0 \leq X \leq X_{1,2}) = P|_{X=0} + \frac{6}{H_p^3} X (H_p - 2Q) \quad (20)$$

$$P(X_{1,2} \leq X \leq X_{1,3}) = P|_{X=X_{1,2}} + 6(X - X_{1,2})(1 - 2Q) \quad (21)$$

where $H_p = 1 + H_g$

Similarly, the nondimensional pressure profiles of groove and land region n respectively of a partially textured parallel slider bearing are

$$P(X_{n,1} \leq X \leq X_{n,2}) = P|_{X=X_{n,1}} + \frac{6}{H_p^3} (X - X_{n,1})(H_p - 2Q) \quad (22)$$

$$P(X_{n,2} \leq X \leq X_{n,3}) = P|_{X=X_{n,2}} + 6(X - X_{n,2})(1 - 2Q) \quad (23)$$

The nondimensional pressure profiles for the exit region of a partially textured parallel slider bearing is

$$P(X_{n,3} \leq X \leq 1) = P|_{X=X_{n,3}} + 6(X - X_{n,3})(1 - 2Q) \quad (24)$$

Substitution of the boundary conditions for nondimensional pressure in Eqs. (4), (7), (10) and simplifying using the nondimensional pressure in Eqs. (20) - (24), results in Q as

$$Q = \frac{\frac{1}{H_p^2} X_{1,2} + (X_{1,3} - X_{1,2}) + \dots + \frac{1}{H_p^2} (X_{n,2} - X_{n,1}) + (X_{n,3} - X_{n,2}) + (1 - X_{n,3})}{\frac{2}{H_p^3} X_{1,2} + 2(X_{1,3} - X_{1,2}) + \dots + \frac{2}{H_p^3} (X_{n,2} - X_{n,1}) + 2(X_{n,3} - X_{n,2}) + 2(1 - X_{n,3})} \quad (25)$$

The nondimensional load capacity and nondimensional friction force of a partially textured parallel slider bearing are obtained by integration of nondimensional pressure and nondimensional shear stress respectively.

3.0 PARTIALLY TEXTURED JOURNAL BEARING ANALYSIS

Figure 2 shows the schematic of partially textured journal bearing representing the inception of partial texture composed of a number of successive regions of groove and land. The angular extent of successive regions of groove and land are $\theta_{1,2} - \theta_{1,1} = \dots = \theta_{n,2} - \theta_{n,1} = \theta_g$ and $\theta_{1,3} - \theta_{1,2} = \dots = \theta_{n,3} - \theta_{n,2} = \theta_d$ respectively.

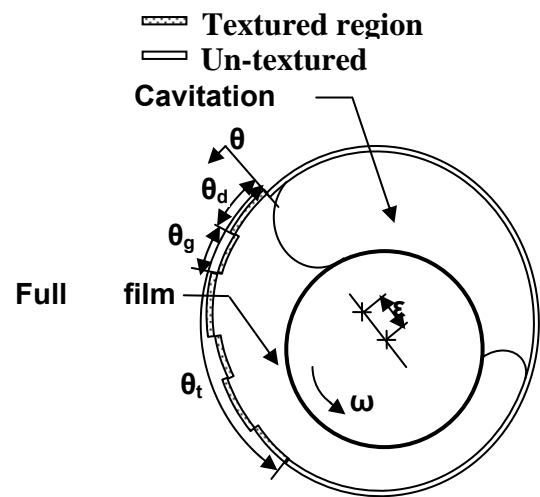


Figure 2 Geometry of partially textured journal bearing

The textured length is θ_t . The specification of texture in journal bearing are: extent of texture region on the bearing surface measured from the position of maximum film thickness (θ), nondimensional depth of groove (H_g), groove to texture region ratio (γ), number of grooves in the texture region (n). Partial texturing at the inlet of sliding surface contact generates higher load capacity (Tønder, 2001).

The nondimensional film thickness in the textured journal bearing is expressed as $H + H_g$, where the nondimensional film thickness H for the plain journal bearing is expressed in Eq. (26) as

$$H = (1 + \varepsilon \cos \theta) \quad (26)$$

The non-dimensional pressure gradient for the plain journal bearing is expressed as

$$\frac{dP}{d\theta} = \frac{6}{H^2} - \frac{12Q}{H^3} \quad (27)$$

The nondimensional shear stress in plain journal bearing is

$$\Pi|_{y=0} = \left(\frac{4}{H} - \frac{6Q}{H^2} \right) \quad (28)$$

3.1 Convergent Journal Bearing

The boundary conditions of groove and land region *l* respectively of partially textured journal bearing are

$$P|_{\theta=0} = 0, P|_{\theta=\theta_{1,2}} = P_{1,2} \text{ and } P|_{\theta=\theta_{1,3}} = P_{1,3} \tag{29}$$

Integrating the Eq. (27) and substituting the boundary conditions given in Eqs. (29), yields the nondimensional pressure profiles of groove and land region *l* as

$$P(0 \leq \theta \leq \theta_{1,2}) = P|_{\theta=0} + 6 \int_0^{\theta} \frac{1}{(H + H_g)^2} d\theta - 12Q \int_0^{\theta} \frac{1}{(H + H_g)^3} d\theta \tag{30}$$

$$P(\theta_{1,2} \leq \theta \leq \theta_{1,3}) = P|_{\theta=\theta_{1,2}} + 6 \int_{\theta_{1,2}}^{\theta} \frac{1}{H^2} d\theta - 12Q \int_{\theta_{1,2}}^{\theta} \frac{1}{H^3} d\theta \tag{31}$$

The boundary conditions of groove and land for region *n* respectively of partially textured journal bearing are

$$P|_{\theta=\theta_{n,1}} = P_{n-1,3}, P|_{\theta=\theta_{n,2}} = P_{n,2} \text{ and } P|_{\theta=\theta_{n,3}} = P_{n,3} \tag{32}$$

Integrating the Eq. (27) and substituting the boundary conditions given in Eqs. (32), yields the nondimensional pressure profiles of groove and land region *n* as

$$P(\theta_{n,1} \leq \theta \leq \theta_{n,2}) = P|_{\theta=\theta_{n,1}} + 6 \int_{\theta_{n,1}}^{\theta} \frac{1}{(H + H_g)^2} d\theta - 12Q \int_{\theta_{n,1}}^{\theta} \frac{1}{(H + H_g)^3} d\theta \tag{33}$$

$$P(\theta_{n,2} \leq \theta \leq \theta_{n,3}) = P|_{\theta=\theta_{n,2}} + 6 \int_{\theta_{n,2}}^{\theta} \frac{1}{H^2} d\theta - 12Q \int_{\theta_{n,2}}^{\theta} \frac{1}{H^3} d\theta \tag{34}$$

Based on the Reynolds boundary conditions for film rupture, the boundary conditions for the exit region are

$$P|_{\theta=\theta_{n,3}} = P_{n,3}, P|_{\theta=\theta_r} = 0 \text{ and } \frac{dP}{d\theta}|_{\theta=\theta_r} = 0 \tag{35}$$

Integrating the Eq. (27) and substituting the boundary conditions given in Eqs. (35), yields the nondimensional pressure profile for exit region as

$$P(\theta_{n,3} \leq \theta \leq \theta_r) = P|_{\theta=\theta_{n,3}} + 6 \int_{\theta_{n,3}}^{\theta} \frac{1}{H^2} d\theta - 12Q \int_{\theta_{n,3}}^{\theta} \frac{1}{H^3} d\theta \tag{36}$$

Substitution of the boundary conditions for nondimensional pressure in Eqs. (29), (32), (35) and simplifying using the nondimensional pressure in Eqs. (30), (31), (33), (34), (36) results in *Q* as

$$Q = \frac{\int_0^{\theta_{1,2}} \frac{1}{(H + H_g)^2} d\theta + \int_{\theta_{1,2}}^{\theta_{1,3}} \frac{1}{H^2} d\theta + \dots + \int_{\theta_{n,1}}^{\theta_{n,2}} \frac{1}{(H + H_g)^2} d\theta + \int_{\theta_{n,2}}^{\theta_{n,3}} \frac{1}{H^2} d\theta + \int_{\theta_{n,3}}^{\theta_r} \frac{1}{H^2} d\theta}{\int_0^{\theta_{1,2}} \frac{2}{(H + H_g)^3} d\theta + \int_{\theta_{1,2}}^{\theta_{1,3}} \frac{2}{H^3} d\theta + \dots + \int_{\theta_{n,1}}^{\theta_{n,2}} \frac{2}{(H + H_g)^3} d\theta + \int_{\theta_{n,2}}^{\theta_{n,3}} \frac{2}{H^3} d\theta + \int_{\theta_{n,3}}^{\theta_r} \frac{2}{H^3} d\theta} \tag{37}$$

Substituting the pressure gradient boundary condition given in Eq. (35) in the expression for nondimensional pressure gradient in Eq. (27), results in

$$Q|_{\theta=\theta_r} = 0.5H|_{\theta=\theta_r} \tag{38}$$

The Newton-Raphson iterative procedure is used to solve simultaneously both θ_r and $Q|_{\theta=\theta_r}$ using Eqs. (35) and (36) (Rao, 2010).

The radial and tangential nondimensional load capacity are obtained by integration of nondimensional pressure along and perpendicular to line of centers as

$$W_\epsilon = - \int_0^{\theta_r} P \cos \theta d\theta, \quad W_\phi = \int_0^{\theta_r} P \sin \theta d\theta \tag{39}$$

The nondimensional load capacity is

$$W = \sqrt{W_\epsilon^2 + W_\phi^2} \tag{40}$$

The nondimensional shear stress of groove and land region *l* is expressed as

$$\Pi(0 \leq \theta \leq \theta_{1,2}) = \frac{4}{(H + H_g)} - \frac{6Q}{(H + H_g)^2} \tag{41}$$

$$\Pi(\theta_{1,2} \leq \theta \leq \theta_{1,3}) = \frac{4}{H} - \frac{6Q}{H^2} \tag{42}$$

The nondimensional shear stress of groove and land region *n* is expressed as

$$\Pi(\theta_{n,1} \leq \theta \leq \theta_{n,2}) = \frac{4}{(H + H_g)} - \frac{6Q}{(H + H_g)^2} \tag{43}$$

$$\Pi(\theta_{n,2} \leq \theta \leq \theta_{n,3}) = \frac{4}{H} - \frac{6Q}{H^2} \tag{44}$$

The nondimensional shear stress for exit region is

$$\Pi(\theta_{n,3} \leq \theta \leq \theta_r) = \frac{4}{H} - \frac{6Q}{H^2} \tag{45}$$

The nondimensional friction force on the journal surface is obtained by integrating the shear stress as

$$F = \int_0^{\theta_r} \Pi d\theta \tag{46}$$

The nondimensional friction coefficient is calculated as

$$C_f = \left(\frac{R}{C} \right) \frac{f}{w} = \frac{F}{W}$$

3.2 Concentric Journal Bearing

The nondimensional pressure profiles for groove and land region l respectively of a partially textured concentric journal bearing are

$$P(0 \leq \theta \leq \theta_{1,2}) = P|_{\theta=0} + \frac{6}{H_p^3} \theta (H_p - 2Q) \quad (47)$$

$$P(\theta_{1,2} \leq \theta \leq \theta_{1,3}) = P|_{\theta=\theta_{1,2}} + 6(\theta - \theta_{1,2})(1 - 2Q) \quad (48)$$

where $H_p = 1 + H_g$

Similarly, the nondimensional pressure profiles for groove and land region n respectively of a partially textured concentric journal bearing are expressed as

$$P(\theta_{n,1} \leq \theta \leq \theta_{n,2}) = P|_{\theta=\theta_{n,1}} + \frac{6}{H_p^3} (\theta - \theta_{n,1})(H_p - 2Q) \quad (49)$$

$$P(\theta_{n,2} \leq \theta \leq \theta_{n,3}) = P|_{\theta=\theta_{n,2}} + 6(\theta - \theta_{n,2})(1 - 2Q) \quad (50)$$

The boundary conditions for the exit region of a partially textured concentric journal bearing is

$$P|_{\theta=\theta_{n,3}} = P_{n,3} \text{ and } P|_{\theta=2\pi} = 0 \quad (51)$$

Integrating the Eq. (27) and substituting the boundary conditions given in Eqs. (51), yields the nondimensional pressure profile for exit region of a partially textured concentric journal bearing as

$$P(\theta_{n,3} \leq \theta \leq 2\pi) = P|_{\theta=\theta_{n,3}} + 6(\theta - \theta_{n,3})(1 - 2Q) \quad (52)$$

Substitution of the boundary conditions for nondimensional pressure in Eqs. (29), (32), (35) and simplifying using the nondimensional pressure in Eqs. (47) - (50), (52) results in Q as

$$Q = \frac{\frac{1}{H_p^2} \theta_{1,2} + (\theta_{1,3} - \theta_{1,2}) + \dots + \frac{1}{H_p^2} (\theta_{n,2} - \theta_{n,1}) + (\theta_{n,3} - \theta_{n,2}) + (2\pi - \theta_{n,3})}{\frac{2}{H_p^3} \theta_{1,2} + 2(\theta_{1,3} - \theta_{1,2}) + \dots + \frac{2}{H_p^3} (\theta_{n,2} - \theta_{n,1}) + 2(\theta_{n,3} - \theta_{n,2}) + 2(2\pi - \theta_{n,3})} \quad (53)$$

The net load support in the bearing is obtained by integration of nondimensional pressure. Integrating the nondimensional shear stress yields the nondimensional friction force on the journal surface.

4.0 RESULTS AND DISCUSSION

Figures 3-6 show the results of non-dimensional load capacity (W) and coefficient of friction (C_f) based on the parameters considered in the study of partially textured slider and journal bearing. The parameters used in the analysis of partially textured slider bearing are: slope parameter for slider bearing (a_h)=0.0, 0.2, 0.4, 0.6 and 0.8; nondimensional texture length for slider bearing (X_t)=0.2, 0.4, 0.6 and 0.8; nondimensional depth of groove (H_g)=1, 2, 3, 4; groove to texture region ratio (γ)=0.2, 0.4, 0.6 and 0.8; number of grooves in the texture region (n)=2, 4, 6 and 8. The parameters used in the analysis of partially textured journal bearing are:

journal eccentricity ratio (ε)=0.0, 0.2, 0.4, 0.6 and 0.8; extent of texture region on the bearing surface measured from the position of maximum film thickness (θ_t)=40°, 80°, 120° and 160°; nondimensional depth of groove (H_g)=1, 2, 3, 4; groove to texture region ratio (γ)=0.2, 0.4, 0.6 and 0.8; number of grooves in the texture region (n)=2, 4, 6 and 8.

Figures 3a-3d show the non-dimensional load capacity (W) of partially textured slider bearing. The non-dimensional load capacity (W) in the case of partially textured parallel slider ($a_h=0.0$) is higher for groove to texture region ratio (γ) of 0.8 and nondimensional texture length for slider bearing (X_t) of 0.6. The non-dimensional load capacity (W) in the case of partially textured parallel slider ($a_h=0.0$) increases with (i) increase in groove to texture region ratio (γ) and decreases with (i) increase in number of grooves in the texture region (n), (ii) increase in nondimensional depth of groove (H_g). For the case of partially textured convergent slider ($a_h=0.8$), the non-dimensional load capacity (W) decreases with (i) increase in nondimensional texture length for slider bearing (X_t), (ii) increase in groove to texture region ratio (γ).

Figures 4a-4d show the coefficient of friction (C_f) of partially textured slider bearing. The coefficient of friction (C_f) in the case of partially textured parallel slider ($a_h=0.0$) is lower for groove to texture region ratio (γ) of 0.8 and nondimensional texture length for slider bearing (X_t) of 0.6. The coefficient of friction (C_f) of partially textured parallel slider bearing ($a_h=0.0$) decreases with (i) increase in the groove to texture region ratio (γ), and (ii) decrease in nondimensional depth of groove (H_g). The coefficient of friction (C_f) of partially textured convergent slider bearing ($a_h=0.8$) increases with (i) increase in nondimensional texture length for slider bearing (X_t), (ii) increase in the groove to texture region ratio (γ).

Figures 5a-5d show the non-dimensional load capacity (W) of partially textured journal bearing. Similar to the case of partially textured parallel slider, the non-dimensional load capacity (W) in the case of partially textured concentric journal bearing ($\varepsilon=0.0$) is higher for groove to texture region ratio (γ) of 0.8 and extent of texture region (θ_t) of 120°. The non-dimensional load capacity (W) in the case of partially textured concentric journal bearing ($\varepsilon=0.0$) increases with increase in extent of texture region (θ_t). In the case of partially textured concentric journal bearing ($\varepsilon=0.0$), the non-dimensional load capacity (W) (i) increases with increase in groove to texture region ratio (γ) and (ii) decreases with increase in nondimensional depth of groove (H_g). For the case of partially textured convergent journal bearing at higher eccentricity ratio ($\varepsilon=0.8$), the non-dimensional load capacity (W) decreases with (i) increase in extent of texture region (θ_t), (ii) increase in nondimensional depth of groove (H_g), and (iii) increase in groove to texture region ratio (γ).

Figures 6a-6d show the coefficient of friction (C_f) of partially textured journal bearing. For the parameters considered in the study for concentric journal bearing ($\varepsilon=0.0$), minimum coefficient of friction (C_f) is obtained groove to texture region ratio (γ) of 0.8 and extent of texture region (θ_t) of 120°. For concentric journal bearing ($\varepsilon=0.0$), the coefficient of friction (C_f) decreases with (i) increase in extent of texture region (θ_t), (ii) increase in groove to texture region ratio (γ), and (iii) decrease in nondimensional depth of groove (H_g). The coefficient of friction (C_f) is not significantly affected in the case of partially textured convergent journal bearing.

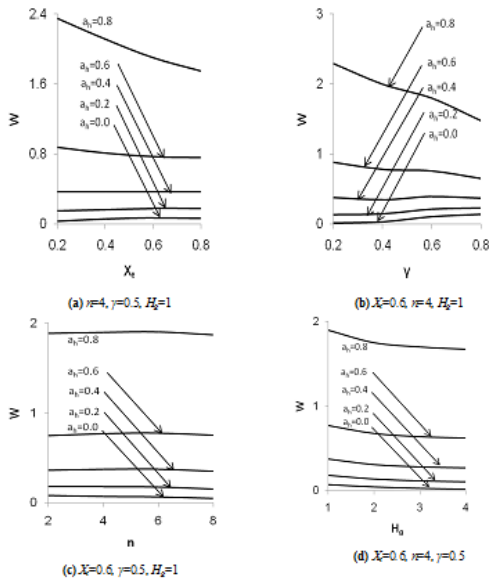


Figure 3 Nondimensional load capacity of partially textured slider bearing

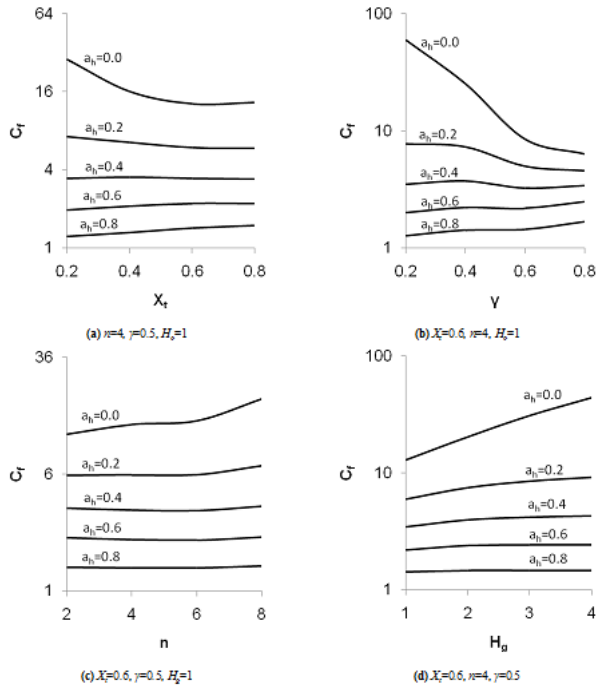


Figure 4 Coefficient of friction of partially textured slider bearing

4.0 CONCLUSION

The present study investigates an improvement in load capacity and reduction in coefficient of friction for partially textured slider and journal bearing. The partial texturing of bearing surfaces is composed of a number of successive regions of groove and land. The conclusions based on the analysis presented in this paper are:

- In the case of partially textured parallel slider bearing, higher non-dimensional load capacity (W) and lower

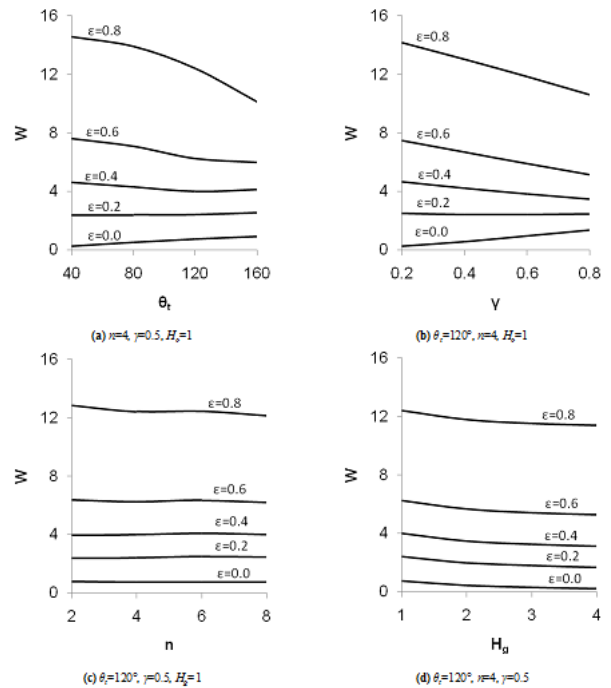


Figure 5 Nondimensional load capacity of partially textured journal bearing

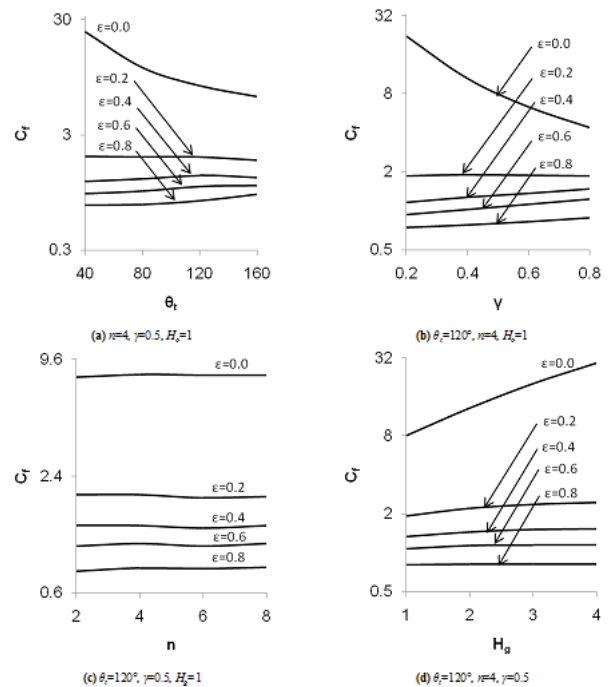


Figure 6 Coefficient of friction of partially textured journal bearing

coefficient of friction (C_f) are obtained for groove to texture region ratio (γ) of 0.8 and nondimensional texture length for slider bearing (X_t) of 0.6. In the case of partially textured convergent slider ($a_h=0.8$), increase in non-dimensional load capacity (W) and decrease in coefficient of friction (C_f) results with (i) decrease in nondimensional texture length for slider bearing (X_t) and (ii) decrease in groove to texture region ratio (γ).

- In the case of partially textured concentric journal bearing ($\epsilon = 0.0$), higher non-dimensional load capacity (W) and

lower coefficient of friction (C_f) are obtained for groove to texture region ratio (γ) of 0.8 and texture region extent (θ_t) of 120°. For the case of partially textured concentric journal bearing ($\varepsilon = 0.0$), the coefficient of friction (C_f) is lower for higher values of (i) groove to texture region ratio (γ) and (ii) extent of texture region (θ_t). The non-dimensional load capacity (W) of partially textured convergent journal bearing ($\varepsilon = 0.8$) increases with (i) decrease in extent of texture region (θ_t), and (ii) decrease in groove to texture region ratio (γ).

Acknowledgement

This research work is funded by Fundamental Research Grant Scheme of Ministry of Higher Education (FRGS-MOHE) Malaysia under grant FRGS/1/2011/TK/UTP/02/10. The authors greatly appreciate the support provided by Universiti Teknologi PETRONAS for this research.

Nomenclature

a_h	Slope parameter for slider bearing	q	Volume flow rate per unit length along film thickness, m^2/s ; $Q = q/Uh_1$ for slider bearing; $Q = q/UC$ for journal bearing
C	Radial clearance, m	R	Journal radius, m
f	Friction force, N; $F = fh_1/\mu UL_s L$ for slider bearing; $F = fC/\mu URL$ for journal bearing	U	Slider velocity along x direction; Journal velocity along θ direction, m/s
h, H	Film thickness, m; $H = h/h_1$ for slider bearing; $H = h/C$ for journal bearing	w	Static load, N; $W = wh_1^2/\mu UL_s^2 L$ for slider bearing; $W = wC^2/\mu UR^2 L$ for journal bearing
h_g, H_g	Depth of groove, m; $H_g = h_g/h_1$ for slider bearing; $H_g = h_g/C$ for journal bearing	W_ε, W_ϕ	Nondimensional radial and tangential static load for journal bearing
H_p	Nondimensional film thickness at groove for parallel slider bearing and concentric journal bearing	x	Coordinate along x direction, m; $X = x/L_s$ for slider bearing; $\theta = x/R$ for journal bearing
$H_{n,1g}, H_{n,2g}$	Nondimensional film thickness at inlet and outlet regions of n^{th} groove for slider bearing	X_g, X_d	Nondimensional length of n^{th} groove and land region for slider bearing
$H_{n,2}, H_{n,3}$	Nondimensional film thickness at inlet and outlet regions of n^{th} land for slider bearing	X_t	Nondimensional texture length for slider bearing
L	Width of slider bearing; Length of the journal bearing, m	y	Coordinate along y direction, m; $Y = y/h_1$ for slider bearing; $Y = y/C$ for journal bearing
L_s	Length of the slider bearing, m	γ	Groove to texture region ratio; $\gamma = X_g/(X_d + X_g)$ for slider bearing; $\gamma = \theta_g/(\theta_d + \theta_g)$ for journal bearing
n	Number of grooves in the texture region	ε	Journal bearing eccentricity ratio
p	Pressure distribution, N/m^2 ; $P = ph_1^2/\mu UL_s$ for slider bearing; $P = pC^2/\mu UR$ for journal bearing	μ	Fluid viscosity, Ns/m^2
$P_{n,1}, P_{n,2}, P_{n,3}$	Nondimensional pressure at the at inlet of n^{th} groove, outlet of n^{th} groove (inlet of n^{th} land), outlet of n^{th} land for slider and journal bearing	θ	Angular coordinate measured from the direction of maximum film thickness in journal bearing
		$\theta_{n,1}, \theta_{n,2}, \theta_{n,3}$	Angular coordinate measured from the direction of maximum film thickness at the at inlet of n^{th} groove, outlet of n^{th} groove (inlet of n^{th} land), outlet of n^{th} land for journal bearing
		θ_g, θ_d	Angular extent of n^{th} groove and land region for journal bearing
		θ_t	Extent of texture region on the bearing surface measured from the position of maximum film thickness
		θ_r	Angular extent of film rupture for journal bearing
		τ	Shear stress component, N/m^2 ; $\Pi = \tau h_1/\mu U$ for slider bearing; $\Pi = \tau C/\mu U$ for journal bearing
		ω	Angular velocity of journal bearing, rad/s

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