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HYDROMAGNETIC SQUEEZE FILM BETWEEN CONDUCTING POROUS TRANSVERSELY ROUGH TRIANGULAR PLATES

[1.] P. A. VADHER, [2.] G. M. DEHERI, [1.] R. M. PATEL

[1.] DEPARTMENT OF PHYSICS, GUJARAT ARTS AND SCIENCE COLLEGE,
AHMEDABAD – 380 006 GUJARAT STATE, INDIA
[2.] DEPARTMENT OF MATHEMATICS, SARDAR PATEL UNIVERSITY,
VALLABH VIDYANAGAR –388 120, GUJARAT STATE, INDIA
[1.] DEPARTMENT OF MATHEMATICS, GUJARAT ARTS AND SCIENCE COLLEGE,
AHMEDABAD – 380 006 GUJARAT STATE, INDIA

ABSTRACT:
An endeavor has been made to study and analyze the effect of transverse surface roughness on the performance of a hydromagnetic squeeze film between conducting porous triangular plates. The transverse roughness of the bearing surfaces is characterized by a stochastic random variable with non zero mean, variance and skewness. Then the associated Reynolds' equation is stochastically averaged with respect to the random roughness parameter. Solving these equations with appropriate boundary conditions the expression for pressure distribution is obtained. From this the expression for load carrying capacity is derived leading to the calculation of response time. The results are presented graphically as well as in tabular form. The results show that the magnetization parameter and the conductivity increase the load carrying capacity while, the load carrying capacity decreases due to porosity and standard deviation. Besides, it is seen that the negatively skewed roughness increases the load carrying capacity substantially especially, when the negative variance is involved. In addition, this investigation sends the signal that the negative effect induced by porosity and the standard deviation can be neutralized upto considerable extent by the positive effect of the magnetization and conductivity in the case of negatively skewed roughness especially, when negative variance occurs.
KEYWORDS: Squeeze film, Hydromagnetic lubrication, Reynolds' equation, Roughness, Load carrying capacity

1. INTRODUCTION

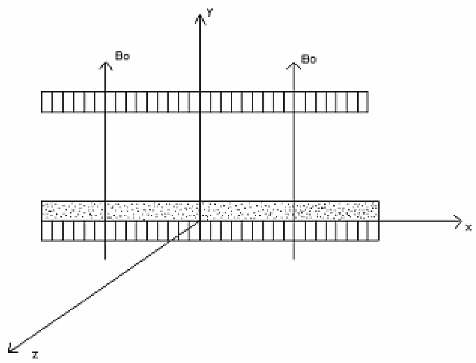
Considerable attention has been focussed to the potentiality of liquid metals as lubricants, utilized under higher temperature at which conventional lubricant would undergo some undesirable physical changes. Inspite of the fact that the liquid metals like mercury, sodium and sodium potassium alloy etc. have a defect as lubricants, at high temperatures these are preferred as lubricants because of their high thermal conductivity and low viscosity (Elco and Huges [9] and stability at high temperature. Since the liquid metals are good conductors of electricity, it becomes possible to increase the load capacity by utilizing the electromagnetic force, thus overcoming the above defect sufficiently and thereby, alleviating the drawback of low viscosity. When a conducting fluid flows across a magnetic field, the electromagnetic pressurization may be substantial. This effect is utilized to improve the lubricating properties of electrically conducting lubricants. Wu [25, 26, 27] and Prakash and Vij [20] analyzed and discussed the behaviour of the squeeze film when one surface was porous and backed by an impermeable solid wall. Prakash and Vij considered several geometries such as circular, annular, elliptical and conical Patel and Gupta [15] investigated the effect of a transverse magnetic field on the behaviour of squeeze film between porous plates of different geometries. Shukla [21] and Kuzma [13] investigated independently, the hydromagnetic theory of squeeze film for conducting lubricants between two conducting non-porous surfaces and studied the effect of the conductivities of surfaces on the load carrying capacity and response time. It was observed that when the bearing surfaces were conducting, load carrying capacity decreased in comparison to the corresponding hydromagnetic case when the bearing surfaces were non-conducting. But the increase in load carrying capacity and time of approach were possible by increasing the conductivities of the surfaces. Prajapati [16] discussed the behaviour of hydromagnetic parallel squeeze film between two conducting porous surfaces. In this study various geometries such as circular, annular, elliptical, conical, infinitely long rectangular were subjected to investigation.Besides, triangular plates were also taken into consideration. It was clear from this article that the conductivity increases the load carrying capacity for all geometrical shapes. Further, it was shown that the plate thicknesses also increase the load carrying capacity and for both small as well as large values of the magnetization parameter the bearing performance suffered when the plates were taken to be electrically conducting in comparison to the hydromagnetic case when the plates were considered to be non-conducting.

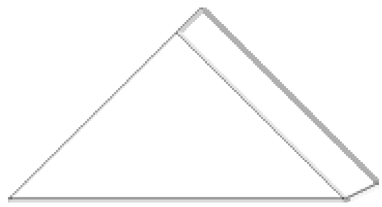
Most of the theoretical studies of bearing lubrication has more or less explicitly assumed that the bearing surfaces can be represented by the smooth mathematical planes. However, it has been recognized that this might be an unrealistic assumption particularly, in bearings working with small film thicknesses. Various devices such as postulating a sinusoidal variation in film thickness (Burton [4]) have been introduced in order to seek more realistic representation of engineering rubbing surfaces. But this method is perhaps more appropriate in an analysis of the influence of waviness rather than roughness. Tzeng and Saibel [24] introduced stochastic concepts and succeeded in conducting an analysis of a two dimensional inclined slider bearing with one dimensional roughness in the direction transverse to the sliding direction. However, bearing surfaces having received some run in and wear seldom exhibit a type of roughness approximated by this model. The effect of surface roughness was studied by many investigators (Davies [8]; Michell [14]; Tonder [23]; Christensen and Tonder ([5] ;[6];[7]); Berthe and Godet [3]). Christensen and Tonder ([5] ;[6];[7]) proposed a comprehensive general analysis both for transverse as well as longitudinal surface roughness. Christensen and Tonder's approach formed the basis of the analysis to study the effect of surface roughness in a number of investigations (Ting [22]; Prakash and Tiwari [19]; Prajapati ([17]; [18]); Guha [11]; Gupta and Deheri [12]; Andharia, Gupta and Deheri ([2]; [1]).

Here, it has been proposed to discuss the effect of transverse surface roughness on the performance of a hydromagnetic squeeze film between porous conducting rectangular plates.

2. ANALYSIS

The geometry and the configuration of bearing system is shown below.





Configuration of the bearing system

The lower plate with a porous facing is assumed to be fixed while, the upper plate moves along its normal towards the lower plate. The plates are taken to be electrically conducting and the clearance space between them is filled by an electrically conducting lubricant. An uniform transverse magnetic field is applied between the plates. The flow in the porous medium obeys the modified form of Darcy's law (Ene [10]), while in the film region the equations of hydromagnetic lubrication theory hold. The bearing is assumed to have transversely rough surfaces. The film thickness $h(x)$ of the lubricant film is

$$h(x) = \bar{h}(x) + h_s(x)$$

where $\bar{h}(x)$ is the mean film thickness and $h(x)$ is the deviation from the mean film thickness characterizing the random roughness of the bearing surfaces and $h_s(x)$ is considered to be stochastic in nature and governed by the probability density function $f(h_s)$, $-c \le h_s \le c$ where c being the maximum deviation from the mean film thickness. The mean α, the standard deviation σ and the parameter ε which is the measure of symmetry, of random variable h_s, are defined by relationships

$$\alpha = E(h_s)$$

$$\sigma^2 = E[(h_s - \alpha)^2]$$

and

$$\varepsilon = E[(h_s - \alpha)^3]$$

where E denotes the expected value defined by

$$E(R) = \int_{-c}^{c} R f(h_s) dh_s$$

Following the usual assumptions of hydromagnetic lubrication the associated Reynolds' equation governing the hydromagnetic flow is given by

$$\frac{\partial^2 p}{\partial x^2} + \frac{\partial^2 p}{\partial z^2} = \frac{h^{\cdot}}{\left[\frac{2A}{\mu M^3}\left(\tanh\frac{M}{2} - \frac{M}{2}\right) - \frac{\psi A}{\mu c^2}\right]} \bullet \frac{1}{\left[\dfrac{\phi_0 + \phi_1 + 1}{\phi_0 + \phi_1 + \frac{\tanh(M/2)}{(M/2)}}\right]} \tag{1}$$

where $A = h^3 + 3h^2\alpha + 3h(\alpha^2 + \sigma^2) + \varepsilon + 3\sigma^2\alpha + \alpha^3$

Solving this equation with the associated boundary conditions, $p(x_1, z_1) = 0$ (2)

leads to the expression for pressure distribution, whose dimensionless form is given by

$$P = \frac{-ph^3}{\mu h^{\cdot} 3\sqrt{3}a^2}$$

$$= \frac{\frac{1}{9\sqrt{3}} \cdot \left[\left(1 - \frac{x}{a}\right)\left(1 - \frac{\sqrt{3}z}{2a} + \frac{x}{2a}\right)\left(1 + \frac{\sqrt{3}z}{2a} + \frac{x}{2a}\right)\right]}{\left[\frac{2B}{M^3}\left(\tanh\frac{M}{2} - \frac{M}{2}\right) - \frac{\psi B}{c^2}\right]} \bullet \frac{1}{\left[\dfrac{\phi_0 + \phi_1 + 1}{\phi_0 + \phi_1 + \frac{\tanh(M/2)}{(M/2)}}\right]} \tag{3}$$

where in $B = 1 + 3\alpha^* + 3(\alpha^{*2} + \sigma^{*2}) + \varepsilon^* + 3\sigma^{*2}\alpha^* + \alpha^{*3}$

Then the load carrying capacity given by $w = \int_{-2a}^{a} \int_{-(x+2a)/\sqrt{3}}^{(x+2a)/\sqrt{3}} p \cdot dx dz$

is obtained in dimensionless form as $W = -\dfrac{wh^3}{27\mu h^{\cdot} a^4}$

$$= \frac{\frac{1}{20\sqrt{3}}}{\left[\frac{2B}{M^3}\left(\tanh\frac{M}{2} - \frac{M}{2}\right) - \frac{\psi B}{c^2}\right]} \bullet \frac{1}{\left[\dfrac{\phi_0 + \phi_1 + 1}{\phi_0 + \phi_1 + \frac{\tanh(M/2)}{(M/2)}}\right]} \tag{4}$$

Lastly, the time ΔT taken by upper plate to reach a film thickness h_1 at t_1 starting from an initial film thickness h_0 at t_0 is determined in non- dimensional form by

$$\Delta T = \int_0^{t_1/t_0} \frac{W h_0^2}{\mu a^4} dt$$

which suggests that

$$\Delta T = \frac{1}{20\sqrt{3}} I \qquad (5)$$

where

$$I = -h_0^2 \int_1^{h_1/h_0} \frac{dh}{\left[\frac{2A}{M^3}\left(\tanh\frac{M}{2} - \frac{M}{2}\right) - \frac{KH}{c^2}\right]} \bullet \frac{1}{\left[\dfrac{\phi_0 + \phi_1 + 1}{\phi_0 + \phi_1 + \dfrac{\tanh(M/2)}{(M/2)}}\right]}$$

3. RESULT AND DISCUSSION

Equation (3) determines the dimensionless pressure while equation (4) presents load carrying capacity. Besides, response time is obtained from equation (5). These three expressions depend on several parameters such as Ψ, M, $\phi_0 + \phi_1$, σ^*, α^* and ε^*. However, from equation (4) and equation (5) it is clear that the expressions for non-dimensional load and response time do not contain 'a' explicitly. Taking the roughness parameters to be zero, this study reduces to the performance of hydromagnetic squeeze film behaviour between porous triangular plates discussed by Prajapati [16]. Further, for non-magnetic porous squeeze film between triangular plates the results of Prakash and Vij [20] are obtained in the limiting case when we take $M \to 0$. Furthermore, the results of Patel and Gupta [15] are recovered when ϕ_0 and ϕ_1 are taken to be zero.

It is noticed that the effect of conductivity on the load carrying capacity W and the response time ΔT comes through the factor $\left(\dfrac{\phi_0 + \phi_1 + \dfrac{\tanh(M/2)}{(M/2)}}{\phi_0 + \phi_1 + 1}\right)$

which for large values of M becomes $\dfrac{\phi_0 + \phi_1}{\phi_0 + \phi_1 + 1}$, because of the fact that $\tanh M \sim 1$ and $2/M \sim 0$. Since both of these functions are increasing functions of $\phi_0 + \phi_1$ it may be observed from the simple mathematical analysis that as $\phi_0 + \phi_1$ increases; the pressure, load carrying capacity and the response time increase. Increase of $\phi_0 + \phi_1$ suggests the increase of the plate conductivities s_0 and s_1 and plate thickness h_0' and h_1'. Hence, as the plate conductivities and plate thicknesses increase, the lubricant pressure, load carrying capacity and response time increase.

The distribution of load carrying capacity with respect to the magnetization parameter for various values of porosity Ψ, conductivity parameter $\phi_0 + \phi_1$, standard deviation σ^*, variance α^* and measure of symmetry ε^* is presented in Fig. 1-5 respectively. It is clearly seen that the magnetization parameter enhances the performance of bearing system significantly as it causes considerable increase in load carrying capacity. Further, it is observed that the increase in load carrying capacity with respect to the magnetization parameter induced by the variance is more as compared to the other parameters. In the case of measure of symmetry also this effect is sharp. It is observed that the effect of standard deviation with respect to the magnetization parameter is negligible upto $\sigma^* = 0.1$.

Next, we have the varaition of load carrying capacity with respect to conductivity parameter $\phi_0 + \phi_1$ for various values of porosity Ψ, standard deviation σ^*, measure of symmetry ε^* and variance α^* in Fig. 6-9 respectively. It is noticed that the conductivity and consequently the plate thicknesses increase the load carrying capacity while, the effect of the porosity and the standard deviation is considerably adverse. It is appealing to see that the effect of standard deviation with respect to the conductivity can be neglected upto the extent $\sigma^* = 0.15$.

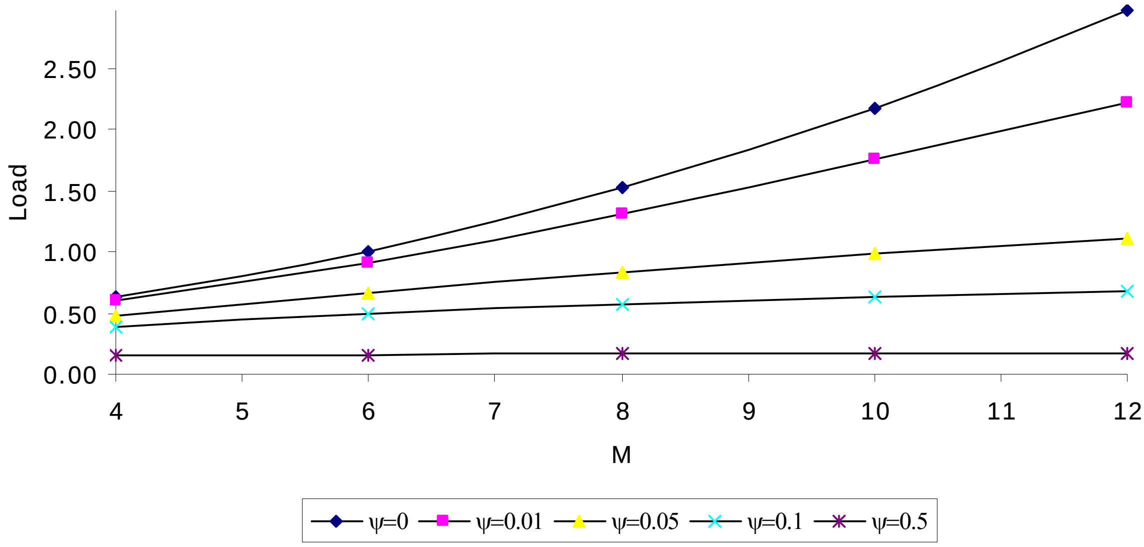


Figure 1: Variation of load carrying capacity with respect to M and ψ

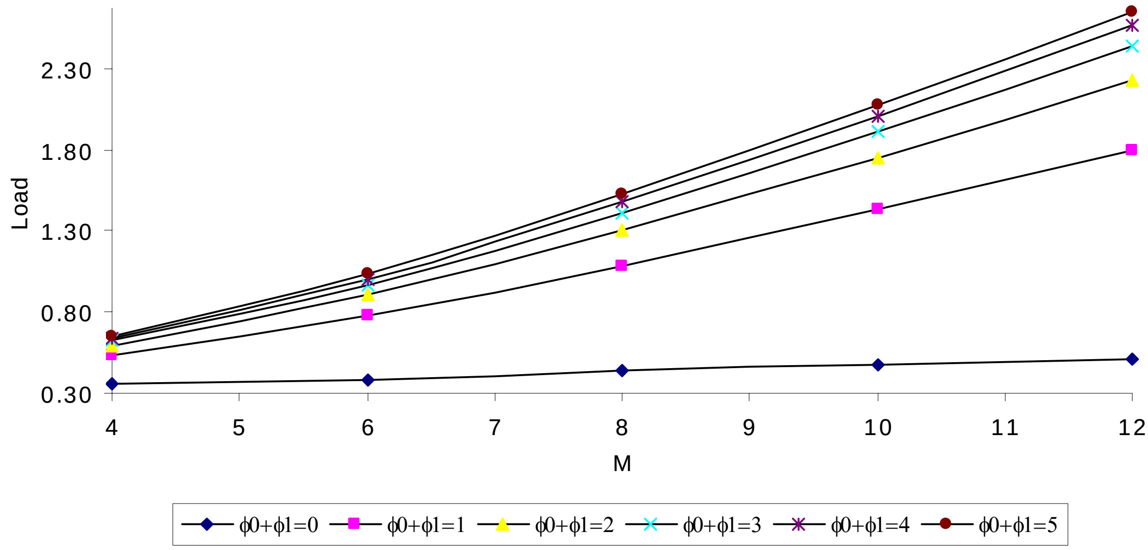


Figure 2: Variation of load carrying capacity with respect to M and $\phi_0+\phi_1$

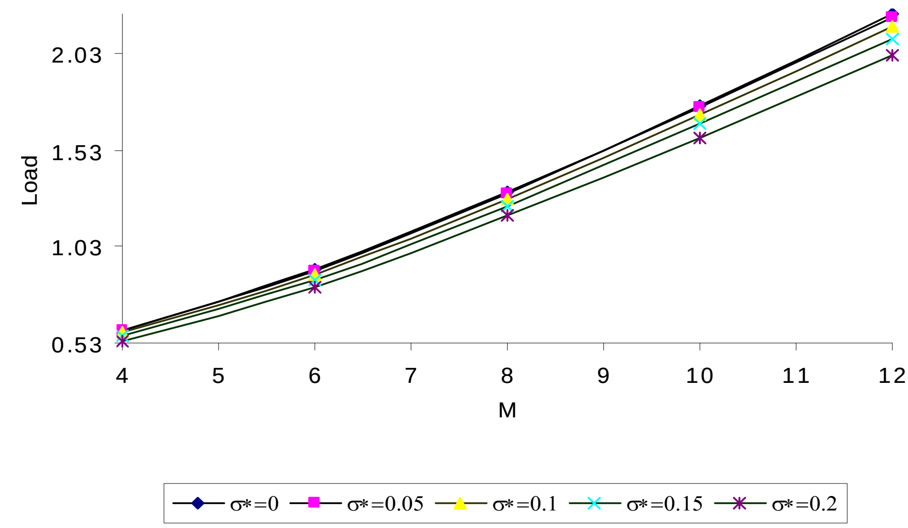


Figure 3: Variation of load carrying capacity with respect to M and σ^*

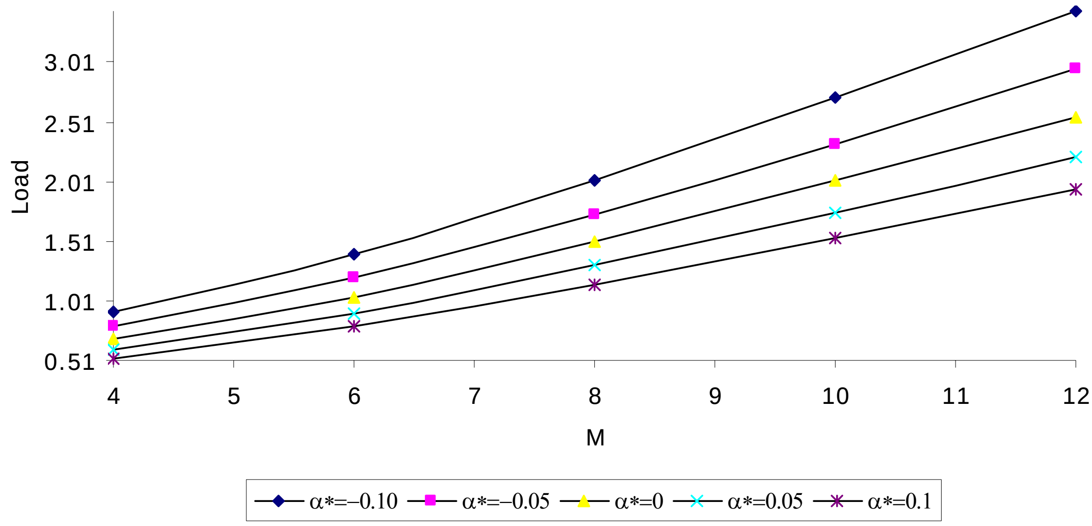


Figure 4: Variation of load carrying capacity with respect to M and α^*

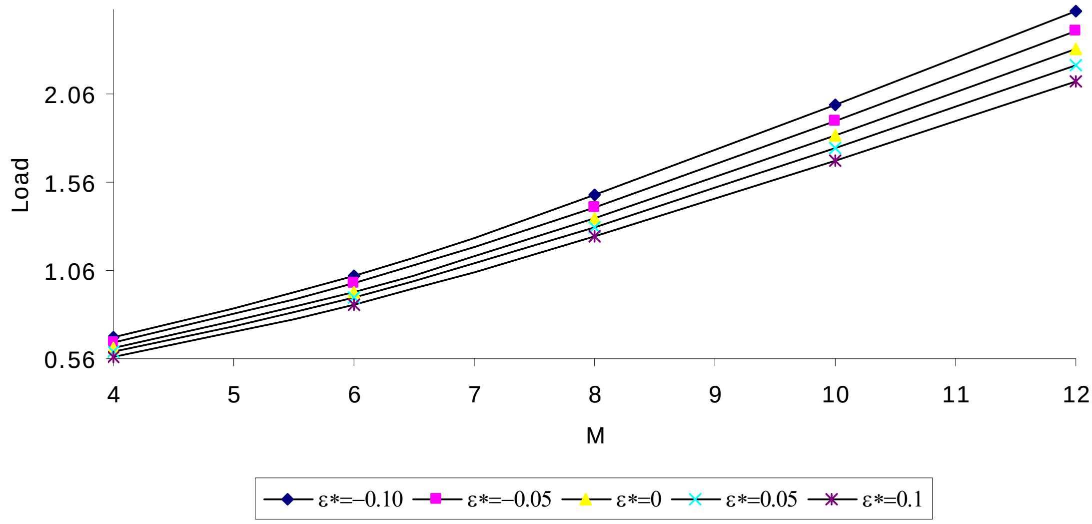


Figure 5: Variation of load carrying capacity with respect to M and ε^*

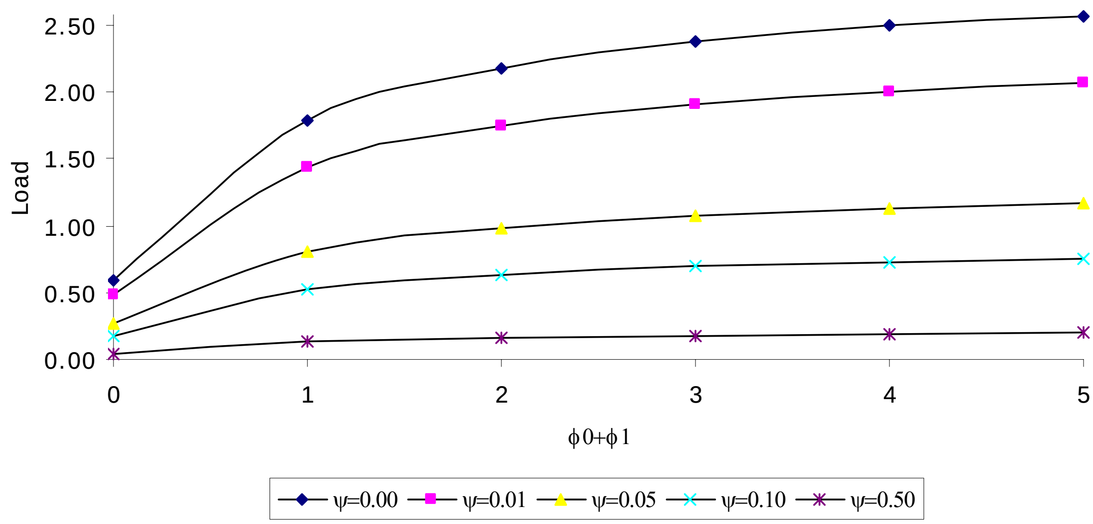


Figure 6: Variation of load carrying capacity with respect to $\phi_0+\phi_1$ and ψ

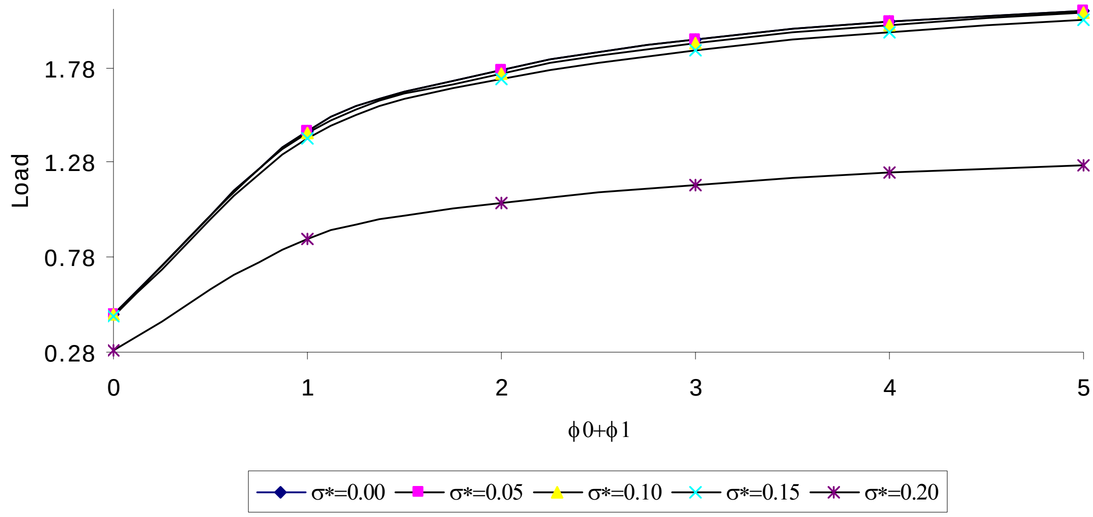


Figure 7: Variation of load carrying capacity with respect to $\phi_0+\phi_1$ and σ^*

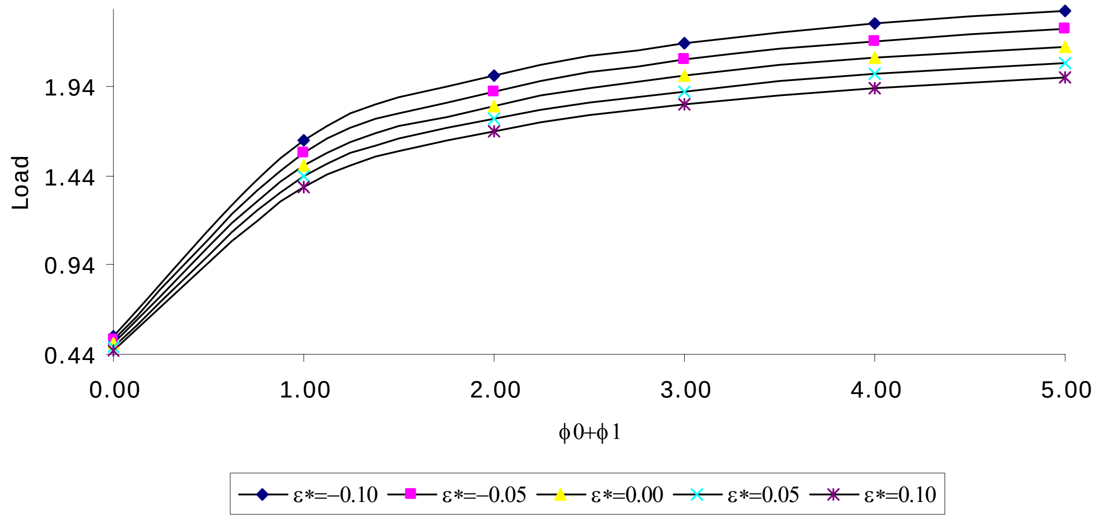


Figure 8: Variation of load carrying capacity with respect to $\phi_0+\phi_1$ and ε^*

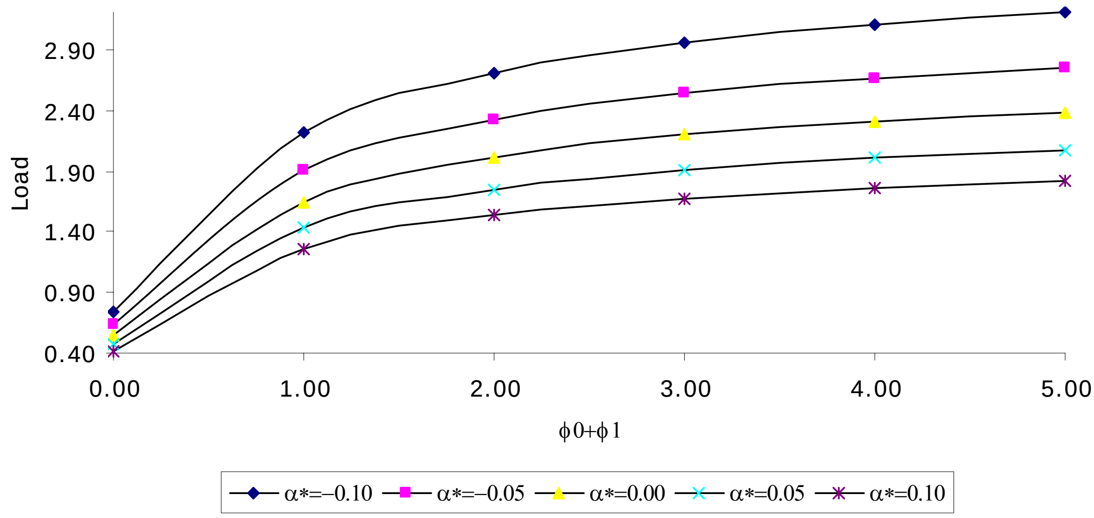


Figure 9: Variation of load carrying capacity with respect to $\phi_0+\phi_1$ and α^*

Fig. 10-12 describe the net effect of porosity and roughness. These figures make it clear that in general the bearing suffers considerably on account of the porosity and the transverse roughness in the sense that the load carrying capacity decreases substantially for increasing values of Ψ,σ*, α*(+ve) and ε*(+ve). However, negatively skewed roughness tends to increase the load carrying capacity. Likewise, the load carrying capacity increases for α*(-ve).

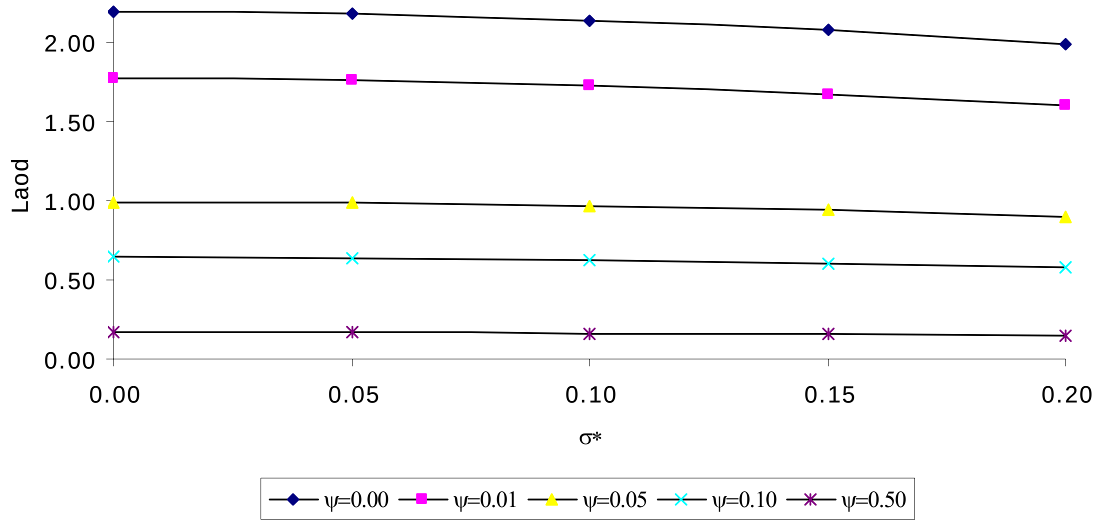


Figure:10: Variation of load carrying capacity with respect to σ* and ψ

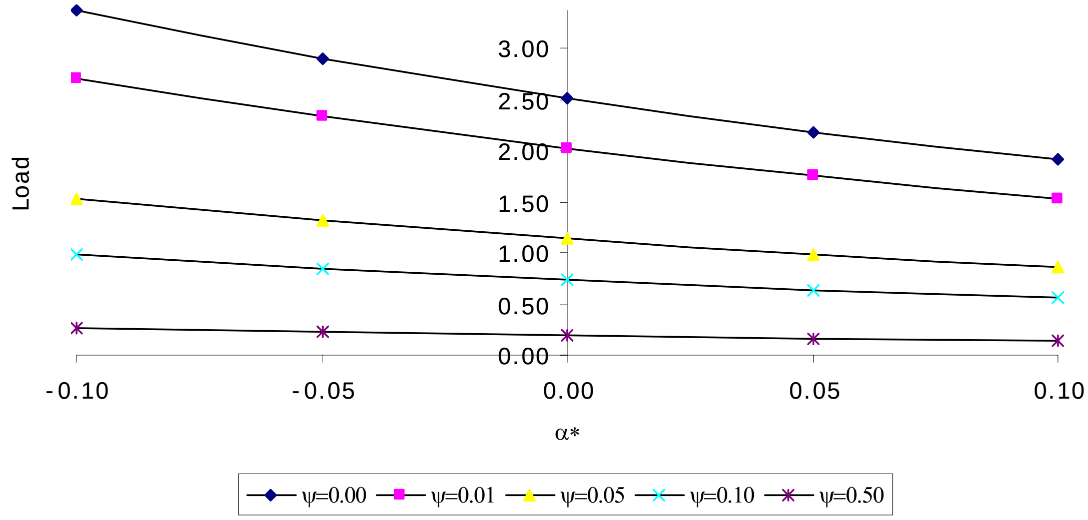


Figure 11: Variation of load carrying capacity with respect to α* and ψ

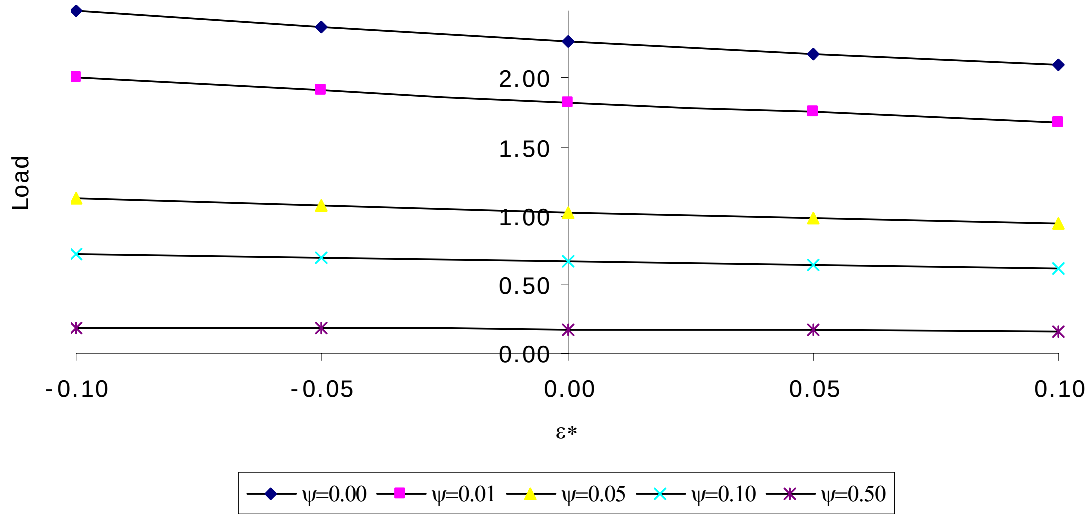


Figure 12: Variation of load carrying capacity with respect to ε* and ψ

The combined effect of the roughness parameters is presented in Fig. 13-15. It is clearly seen that the standard deviation has a considerable negative effect on the performance of the bearing system. Even the effect of α^*(+ve) and ε^*(+ve) is adverse. However, the combined effect of ε^*(-ve) and α^*(-ve) is significantly positive.

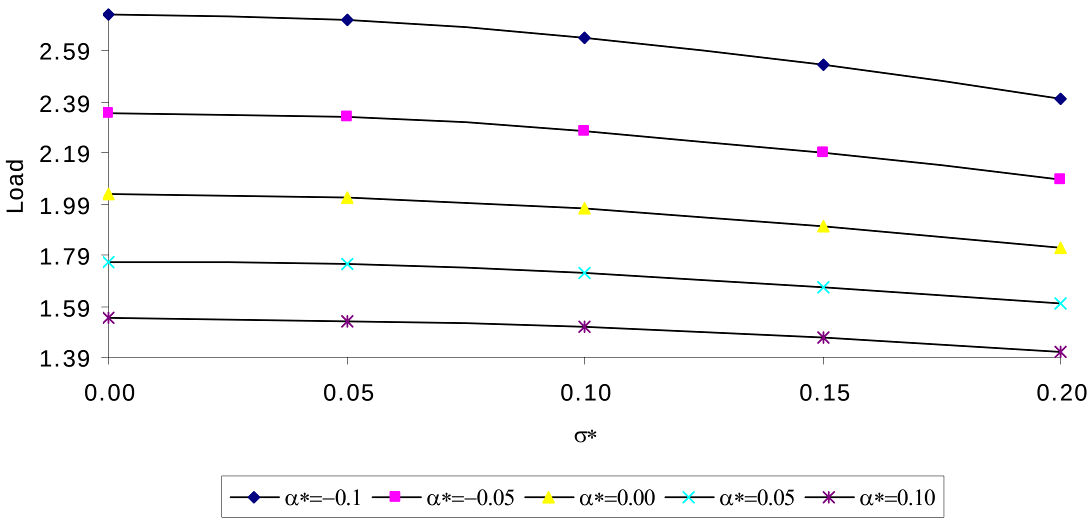


Figure 13: Variation of load carrying capacity with respect to σ^* and α^*

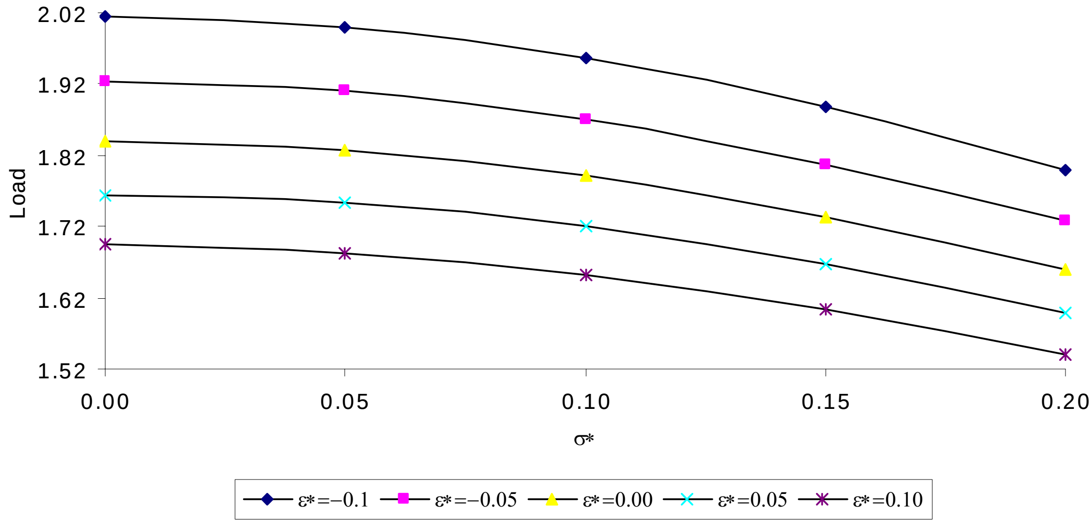


Figure 14: Variation of load carrying capacity with respect to σ^* and ε^*

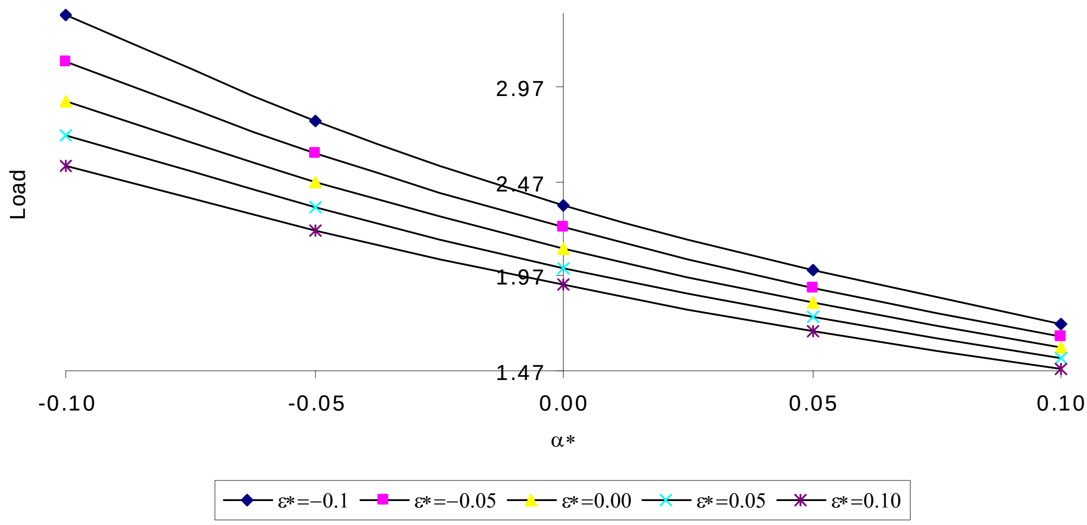


Figure15: Variation of load carrying capacity with respect to α^* and ε^*

Table 1: Variation of Response Time with respect to M and ψ.

	ψ=0	ψ=0.01	ψ=0.05	ψ=0.1	ψ=0.5
M=4	0.16289	0.13238	0.06965	0.03924	0.00455
M=6	0.25675	0.20062	0.09441	0.04897	0.00471
M=8	0.39124	0.28979	0.11998	0.05755	0.00483
M=10	0.56037	0.38941	0.14199	0.06392	0.00489
M=12	0.76292	0.49341	0.15985	0.06850	0.00492

Table 2: Variation of Response Time with respect to M and $\phi0+\phi1$.

	$\phi0+\phi1$=0	$\phi0+\phi1$=1	$\phi0+\phi1$=2	$\phi0+\phi1$=3	$\phi0+\phi1$=4	$\phi0+\phi1$=5
M=4	0.07939	0.11913	0.13238	0.13901	0.14298	0.14563
M=6	0.08598	0.17196	0.20062	0.21495	0.22354	0.22928
M=8	0.09660	0.24149	0.28979	0.31394	0.32843	0.33809
M=10	0.10620	0.31861	0.38941	0.42481	0.44605	0.46021
M=12	0.11386	0.39852	0.49341	0.54085	0.56931	0.58829

Table 3: Variation of Response Time with respect to M and σ^*.

	σ^*=0	σ^*=0.05	σ^*=0.1	σ^*=0.15	σ^*=0.2
M=4	0.13431	0.13238	0.12683	0.11833	0.10781
M=6	0.20354	0.20062	0.19221	0.17933	0.16337
M=8	0.29402	0.28979	0.27764	0.25904	0.23600
M=10	0.39509	0.38941	0.37308	0.34808	0.31712
M=12	0.50061	0.49341	0.47272	0.44105	0.40181

Table 4: Variation of Response Time with respect to M and α^*.

	α^*=–0.10	α^*=–0.05	α^*=0	α^*=0.05	α^*=0.1
M=4	0.20077	0.17616	0.15340	0.13238	0.11311
M=6	0.30425	0.26695	0.23247	0.20062	0.17141
M=8	0.43949	0.38561	0.33581	0.28979	0.24761
M=10	0.59056	0.51817	0.45124	0.38941	0.33272
M=12	0.74828	0.65655	0.57175	0.49341	0.42158

Table 5: Variation of Response Time with respect to M and ε^*.

	ε^*=–0.10	ε^*=–0.05	ε^*=0	ε^*=0.05	ε^*=0.1
M=4	0.18226	0.16282	0.14640	0.13238	0.12032
M=6	0.27620	0.24674	0.22186	0.20062	0.18234
M=8	0.39897	0.35642	0.32047	0.28979	0.26338
M=10	0.53611	0.47895	0.43063	0.38941	0.35392
M=12	0.67929	0.60686	0.54564	0.49341	0.44844

Table 6: Variation of Response Time with respect to $\phi0+\phi1$ and ψ

	ψ=0.00	ψ=0.01	ψ=0.05	ψ=0.10	ψ=0.50
$\phi0+\phi1$=0	0.15283	0.10620	0.03872	0.01743	0.00133
$\phi0+\phi1$=1	0.45848	0.31861	0.11617	0.05230	0.00400
$\phi0+\phi1$=2	0.56037	0.38941	0.14199	0.06392	0.00489
$\phi0+\phi1$=3	0.61131	0.42481	0.15490	0.06973	0.00533
$\phi0+\phi1$=4	0.64188	0.44605	0.16264	0.07322	0.00560
$\phi0+\phi1$=5	0.66225	0.46021	0.16780	0.07555	0.00578

Table 7: Variation of Response Time with respect to $\phi 0+\phi 1$ and σ^*

	$\sigma^*=0.00$	$\sigma^*=0.05$	$\sigma^*=0.10$	$\sigma^*=0.15$	$\sigma^*=0.20$
$\phi 0+\phi 1=0$	0.10775	0.10687	0.10373	0.09795	0.05781
$\phi 0+\phi 1=1$	0.32326	0.32060	0.31118	0.29385	0.17343
$\phi 0+\phi 1=2$	0.39509	0.39185	0.38034	0.35915	0.21198
$\phi 0+\phi 1=3$	0.43101	0.42747	0.41491	0.39179	0.23125
$\phi 0+\phi 1=4$	0.45256	0.44884	0.43566	0.41138	0.24281
$\phi 0+\phi 1=5$	0.46692	0.46309	0.44949	0.42444	0.25052

Table 8: Variation of Response Time with respect to $\phi 0+\phi 1$ and ε^*

	$\varepsilon^*=-0.10$	$\varepsilon^*=-0.05$	$\varepsilon^*=0.00$	$\varepsilon^*=0.05$	$\varepsilon^*=0.10$
$\phi 0+\phi 1=0$	0.14621	0.13062	0.11745	0.10620	0.09652
$\phi 0+\phi 1=1$	0.43864	0.39186	0.35234	0.31861	0.28957
$\phi 0+\phi 1=2$	0.53611	0.47895	0.43063	0.38941	0.35392
$\phi 0+\phi 1=3$	0.58485	0.52249	0.46978	0.42481	0.38610
$\phi 0+\phi 1=4$	0.61409	0.54861	0.49327	0.44605	0.40540
$\phi 0+\phi 1=5$	0.63359	0.56603	0.50893	0.46021	0.41827

Table 9: Variation of Response Time with respect to $\phi 0+\phi 1$ and α^*

	$\alpha^*=-0.10$	$\alpha^*=-0.05$	$\alpha^*=0.00$	$\alpha^*=0.05$	$\alpha^*=0.10$
$\phi 0+\phi 1=0$	0.16106	0.14132	0.12307	0.10620	0.09074
$\phi 0+\phi 1=1$	0.48319	0.42396	0.36920	0.31861	0.27223
$\phi 0+\phi 1=2$	0.59056	0.51817	0.45124	0.38941	0.33272
$\phi 0+\phi 1=3$	0.64425	0.56527	0.49226	0.42481	0.36297
$\phi 0+\phi 1=4$	0.67646	0.59354	0.51688	0.44605	0.38112
$\phi 0+\phi 1=5$	0.69794	0.61238	0.53329	0.46021	0.39322

Table 10: Variation of response time with respect to ψ and σ^*

	$\sigma^*=0.00$	$\sigma^*=0.05$	$\sigma^*=0.10$	$\sigma^*=0.15$	$\sigma^*=0.20$
$\psi=0.00$	0.56930	0.56037	0.53483	0.49604	0.44853
$\psi=0.01$	0.39509	0.38941	0.37308	0.34808	0.31712
$\psi=0.05$	0.14365	0.14199	0.13717	0.12968	0.12018
$\psi=0.10$	0.06457	0.06392	0.06204	0.05909	0.05530
$\psi=0.50$	0.00493	0.00489	0.00478	0.00461	0.00439

Table 11: Variation of Response Time with respect to ψ and α^*

	$\alpha^*=-0.1$	$\alpha^*=-0.05$	$\alpha^*=0.00$	$\alpha^*=0.05$	$\alpha^*=0.10$
$\psi=0.00$	0.84712	0.74580	0.65022	0.56037	0.47696
$\psi=0.01$	0.59056	0.51817	0.45124	0.38941	0.33272
$\psi=0.05$	0.21684	0.18886	0.16406	0.14199	0.12234
$\psi=0.10$	0.09800	0.08501	0.07374	0.06392	0.05533
$\psi=0.50$	0.00754	0.00650	0.00563	0.00489	0.00426

Table 12: Variation of Response Time with respect to ψ and ε^*

	$\varepsilon^*=-0.1$	$\varepsilon^*=-0.05$	$\varepsilon^*=0.00$	$\varepsilon^*=0.05$	$\varepsilon^*=0.10$
$\psi=0.00$	0.79980	0.70462	0.62607	0.56037	0.50477
$\psi=0.01$	0.53611	0.47895	0.43063	0.38941	0.35392
$\psi=0.05$	0.18186	0.16687	0.15367	0.14199	0.13159
$\psi=0.10$	0.07889	0.07336	0.06839	0.06392	0.05989
$\psi=0.50$	0.00570	0.00541	0.00514	0.00489	0.00466

Table 13: Variation of Response Time with respect to σ^* and α^*

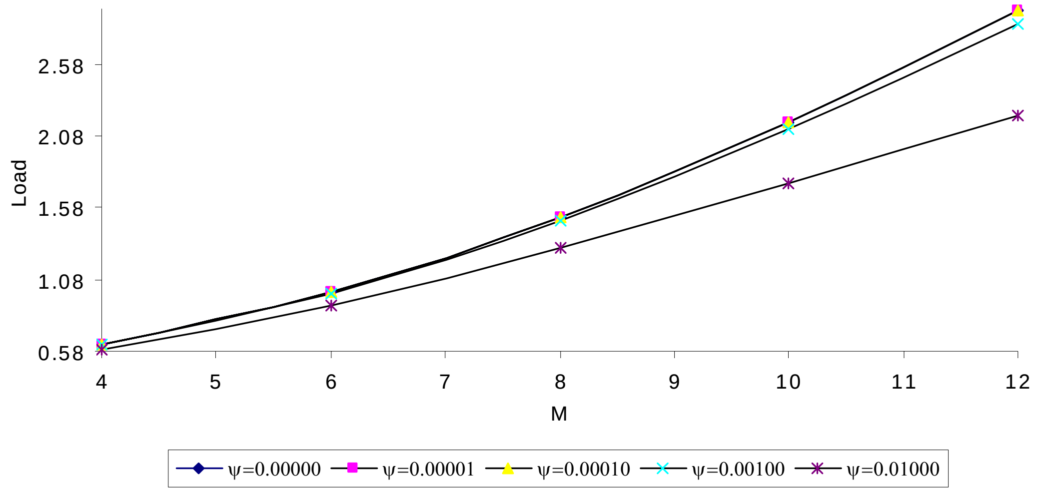
	$\alpha^*=-0.1$	$\alpha^*=-0.05$	$\alpha^*=0.00$	$\alpha^*=0.05$	$\alpha^*=0.10$
$\sigma=0.00$	0.59960	0.52598	0.45794	0.39509	0.33747
$\sigma=0.05$	0.59056	0.51817	0.45124	0.38941	0.33272
$\sigma=0.10$	0.56465	0.49576	0.43201	0.37308	0.31907
$\sigma=0.15$	0.52512	0.46153	0.40258	0.34808	0.29813
$\sigma=0.20$	0.47643	0.41927	0.36620	0.31712	0.27215

Table 14: Variation of Response Time with respect to σ^* and ε^*

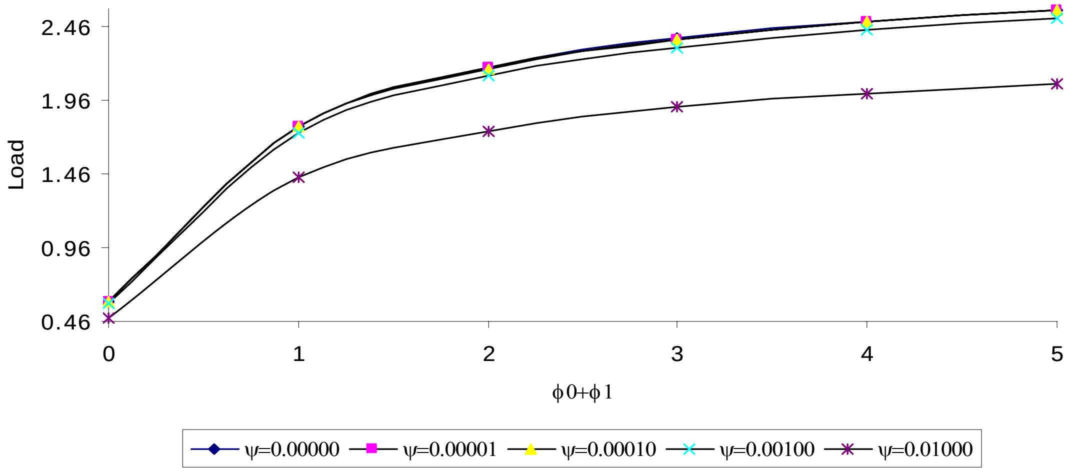
	$\varepsilon^*=-0.1$	$\varepsilon^*=-0.05$	$\varepsilon^*=0.00$	$\varepsilon^*=0.05$	$\varepsilon^*=0.10$
$\sigma=0.00$	0.54538	0.48674	0.43726	0.39509	0.35883
$\sigma=0.05$	0.53611	0.47895	0.43063	0.38941	0.35392
$\sigma=0.10$	0.50972	0.45667	0.41165	0.37308	0.33978
$\sigma=0.15$	0.46990	0.42288	0.38270	0.34808	0.31803
$\sigma=0.20$	0.42162	0.38157	0.34707	0.31712	0.29094

Table 15: Variation of Response Time capacity with respect to α^* and ε^*

	$\varepsilon^*=-0.1$	$\varepsilon^*=-0.05$	$\varepsilon^*=0.00$	$\varepsilon^*=0.05$	$\varepsilon^*=0.10$
$\alpha=-0.10$	0.87720	0.76182	0.66797	0.59056	0.52596
$\alpha=-0.05$	0.74823	0.65679	0.58127	0.51817	0.46487
$\alpha=0.00$	0.63571	0.56314	0.50249	0.45124	0.40753
$\alpha=0.05$	0.53611	0.47895	0.43063	0.38941	0.35392
$\alpha=0.10$	0.44789	0.40343	0.36545	0.33272	0.30430



APPENDIX - Figure A1: Variation of load carrying capacity with respect to M and ψ



APPENDIX - Figure A2: Variation of load carrying capacity with respect to $\phi0+\phi1$ and ψ

This investigation suggests that the porosity effects are negligible upto $\psi \approx 0.001$ (c.f. Appendix Fig. A1-A2). A cursory glance at some of the figures indicates that for both small as well as large values of M, the bearing performance suffers when the plates are taken to be electrically conducting in comparison to the hydromagnetic case when the plates are considered to be non- conducting. This can physically be explained by fringing phenomena which occurs when the plates are conducting.

4. CONCLUSIONS

A close scrutiny of some of the figures suggest that the negative effect induced by porosity and standard deviation can be compensated up to a considerable extent by the positive effect of magnetization and conductivity in the case of negatively skewed roughness especially, when negative variance occurs. Further, this discussion reveals that there are enough scopes for extending the life period of the bearing system.

Thus, this article makes it mandatory that the roughness must be accorded due priority while designing the bearing system.

Nomenclature

a	Length of the sides
h	Lubricant film thickness
H	Magnetic field component
K	Permeability
m	Porosity of the porous matrix
M	$= B_0 h \left(\frac{s}{\mu}\right)^{1/2}$ = Hartmann number
p	Pressure distribution
P	Non-dimensional pressure
s	Electrical conductivity of the lubricant
w	Load carrying capacity
W	Dimensionless load carrying capacity
B_0	Uniform transverse magnetic field applied between the plates
c^2	$= 1 + \frac{KM^2}{h^2 m}$
h_0'	Surface width of the lower plate
h_1'	Surface width of the upper plate
s_0	Electrical conductivity of lower surface
s_1	Electrical conductivity of upper surface
Δt	Response time
ΔT	Non-dimensional response time
$\phi_0(h)$	$= \frac{s_0 h_0'}{sh}$
$\phi_1(h)$	$= \frac{s_1 h_1'}{sh}$
ψ	$= \frac{KH}{h^3}$ = Porosity
μ	Viscosity
$\bar{\mu}$	Magnetic susceptibility
μ_0	Permeability of the free space
σ^*	Non-dimensional standard deviation (σ/h)
α^*	Non-dimensional variance (α/h)
ε^*	Non-dimensional skew ness (ε/h^3)

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