Commentry
Volume 11:3, 2020
DOI: 10.37421/jpm.2020.11.320

Journal of Physical Mathematics

ISSN: 2090-0902 Open Access

Behavior of Synovial fluid in a Channel

Sushil Kumar[1]* and AK Yadav[2]

[1]Department of Mathematics C.C.S. P.G. College Heonra, Etawah (U.P)

[2]Department of Mathematics Govt. P.G. College, Datia (MP)

Abstract

The present study is dotted to investigate analytically the behavior of synovial fluid in a channel these studies have enabled the beseechers to analyze the lubsicati on mechanism and statistical behviour of synovial fluid.

Keywords: Synovial fluid • Load capacity • Intestinal fluid • Cartilage synovial joint

Introduction

Synovial fluid an ultsatiltsate of blood with additives bloduced by the synoviam has a number of biological synovial fluid because castilage lacks its own blood synovial joins eahibet salient fetuses which are extra oldnasy an the mechanical sense. They are freely moving low frictional junctures characterized by minimal energy dissipation. Several types of lubrication mechanism are believed to occus in the functioning of human joints. Synovial fluid is a viscous, non-newtonian fluid found in the cavities of synovial joints. Synovial fluid is reduce friction between the articular cartilage of synovial joints during movement. The inner membrane of synovial joints is called the synovial membrane and secretes synovial fluid into the joint cavity the fluid contains hyaluronic acid secreted by fibroblast-like cells in the synovial membrane and interstitial fluid filtered from the blood plasma [1]. The fluid forms a thin larger at the surface of cartilage and also seeps into micro cavities and irregularities in the articular cartilage surface, filling in the empty space [2].

Synovial tissue is sterile and composed of vascularized connective tissue that lacks a basement membrane. Synovial fluid is made of hyaluronic acid and lubricant proteinases and collagenases. Synovial fluid exhaled non-Newtonian flow characteristics, the viscosity coefficient is not a constant and the fluid is not linearly viscous.

Human moveable joints have coefficient of friction much smaller than any man-made machine. This efficiency is due to perfect combination of amazing materials-elastic cartilage and viscous-elastic cartilage and viscous-elastic synovial fluid.

M.c catchan [3] has suggested that in regards to hydraulic boundary condition of cartilage. The relationship between pressure within the liquid film in the gap and the time dependent deformation of the cartilage was worked out by M.c catchan [4], Lirg [1] and Yadav [5]. Mrouctal [6], Mansur [2] provided result for cartilage deformation produced by compressive stream.

In this paper we have made an attempt to study the axial pressure and load bearing capacity of the cartilage between two approaching surfaces [7] (Figures 1-4) (Tables 1 and 2).

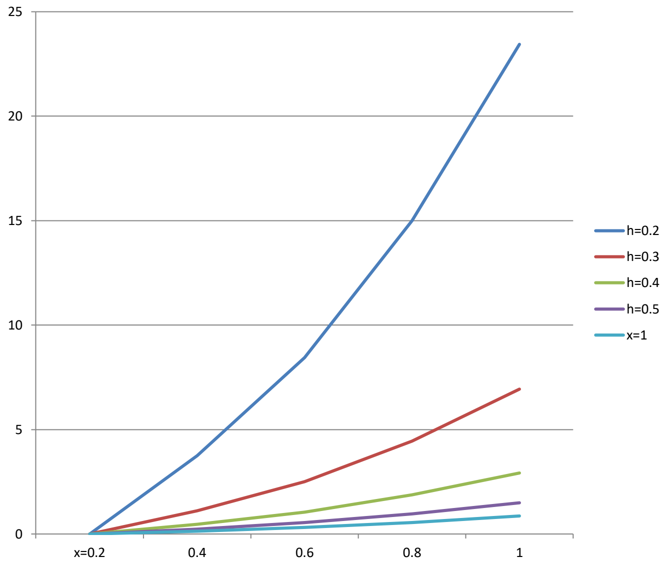

Figure 1. Variation of axial pressure with flow behavior for different value of h&x.

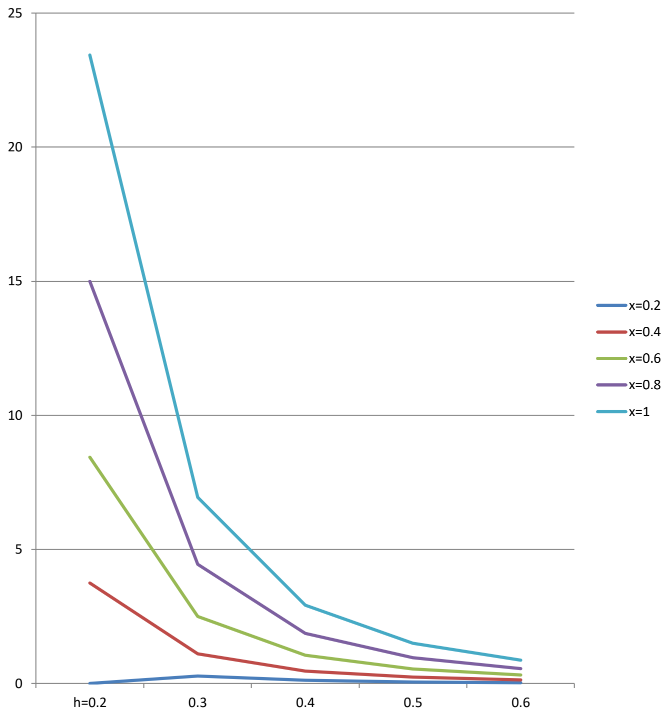

Figure 2. Variation of axial pressure with flow behavior for different value of h&x.

***Address for Correspondence:** Sushil kumar, Department of Mathematics C.C.S. P.G. College Heonra, Etawah (U.P), India, Tel: 9927489684, E-mail: sushil.skb87@gmail.com*

Received 25 March 2020; **Accepted** 22 July 2020; **Published** 22 July 2020

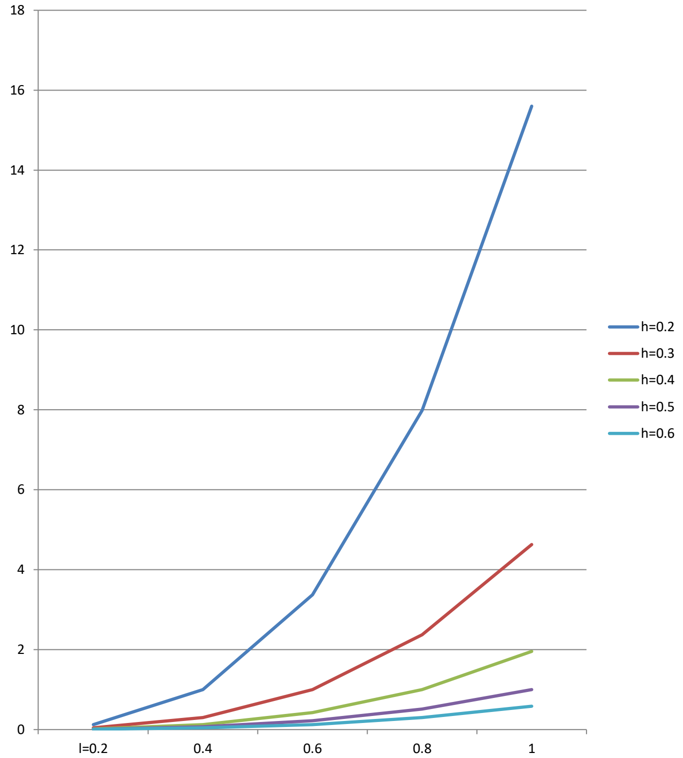

Figure 3. Variation of Load Carrying Capacity w for different value of h &L , at μ= 5, ν= 5.

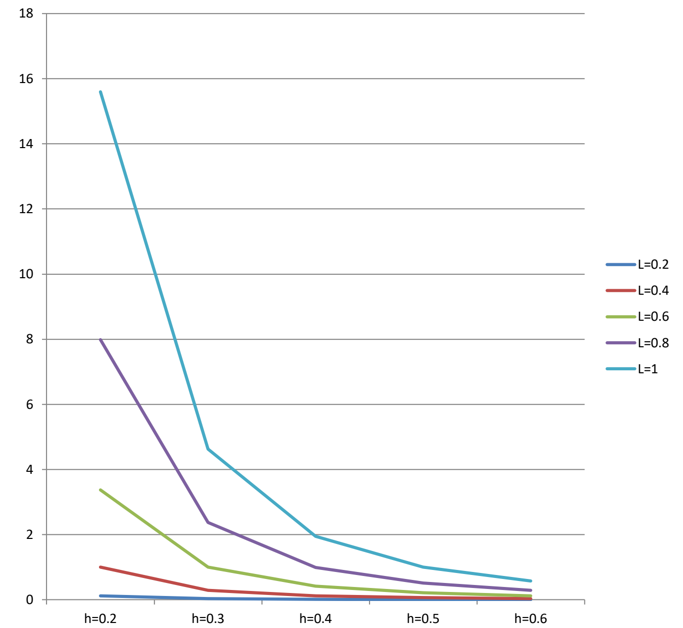

Figure 4. Variation of Load Carrying Capacity w for different value of h &L , at μ= 5, ν=5.

Formulation of the problem

The governing equation for two dimensional laminar flow in a channel given below;

$$-\frac{\partial p}{\partial x}+\mu\frac{\partial u}{\partial y} = 0 \quad (1)$$

The equation of continuity

$$\frac{\partial u}{\partial x}+\frac{\partial u}{\partial y}=0 \quad (2)$$

The solution of the equation subject to the boundary condition;

u=0 at y= h

Table 1. Variation of axial pressure p for different value of x, h but μ=5 & ν=5.

x \ h	0.2	0.3	0.4	0.5	0.6
0.2	0.9375	0.2777	0.1171	0.0600	0.03472
0.4	3.7488	1.1111	0.4672	0.2400	0.13888
0.6	8.4348	2.5000	1.0512	0.5400	0.31248
0.8	14.9952	4.4416	1.8688	0.9600	0.55552
1.0	23.4300	6.9400	2.9200	1.5000	0.8680

Table 2. Variation of Load carring capacity w for different value of h, L But but μ=5 & ν=5.

L \ h	0.2	0.3	0.4	0.5	0.6
0.2	0.125000	0.037032	0.015600	0.00800	0.0046290
0.4	1.000000	0.296256	0.124800	0.06400	0.0370368
0.6	3.369600	0.999864	0.421200	0.21600	0.1249900
0.8	7.987200	2.370048	0.998400	0.51200	0.2962944
1.0	15.600000	4.629000	1.950000	1.00000	0.5787000

u=0 at y=-h

and p=0 at x=0 (4)

the model equation

$$\frac{\partial^2 u}{\partial y^2}=\frac{1}{\mu}\frac{\partial p}{\partial x} \quad (5)$$

Solution of the problem

If the pressure gradient exist along

Integration equation, we get

$$\mu=\frac{1}{2\mu}\left(y^2-h^2\right)\frac{\partial p}{\partial x} \quad (6)$$

from equation of continuity, we have

$$\int_0^h u dy=-\tfrac{1}{2}vx \quad (7)$$

$$\frac{1}{3\mu}h^3\frac{\partial p}{\partial x}=\tfrac{1}{2}vx$$

$$\frac{1}{\mu}\frac{\partial p}{\partial x}=\frac{3}{2}\frac{vx}{h^3} \quad (8)$$

From equation (6) and (8), we get

$$u=\frac{3vx}{4h^3}(y^2-h^2) \quad (9)$$

differentiate equation (9), we get

$$\frac{\partial u}{\partial y}=\frac{3vx}{2h^3}y \quad (10)$$

Again differentiate equation (10),

Partially w.r. to y, we get

$$\frac{\partial^2 u}{\partial y^2}=\frac{3vx}{2h^3} \quad (11)$$

From equation (11) & (5), we get

$$\frac{\partial p}{\partial x}=\frac{3\mu vx}{2h^3} \quad (12)$$

Integrating equation (12), w.r.to x, we get

$$p=\frac{3\mu vx^2}{4h^3}+A \quad (13)$$

Solution of equation (13) under the boundary condition (4)

We get

$$p=\frac{3\mu vx^2}{4h^3} \quad (14)$$

The load capacity is given by

$$w = 2\int_0^L p dx \quad (15)$$

$$= \frac{3}{2}\left(\frac{\mu v L^3}{3h^3}\right)$$

$$= \frac{1}{2}\left(\frac{\mu v L^3}{h^3}\right) \quad (16)$$

Results and Conclusion

The research paper proposed a more elastic model for explaining the lubrication mechanism occurring a normally pressure and load capacity. The result for axial pressure and load bearing capacity has been examined for different values of *h*, *x* and *L*.

We observe that the axial pressure increases with the increase the value of *x* and decrease with the increase of value *h*.

We have also observed that the load carrying capacity increases as with the increase of the value of film thickness. Again we observed that the load carrying capacity depends on the flow behavior and the gap between the approaching surfaces.

Reference

1. Ling, FF. "A new model of articular cartilage in human joints." *J Lubrication Tech* (1974):449-454.
2. Mansour, Joseph M, and Van C Mow. "On the natural lubrication of synovial joints: Normal and degenerate." *J Lubrication Tech* (1977):163-172.
3. McCutchen, C.W. "An approximate equation for weeping lubrication, solved with an electrical analogue." *Annals of the rheumatic diseases* 34 (1975):85.
4. McCutchen, Charles W. "The frictional properties of animal joints." *Wear* 5 (1962):1-17.
5. Yadav, AK and SC Pokhriyal "Synovial fluid behavior in reference to animal joints." *Indian Jr Pure and Apple Sci* 16 (2000):311-316.
6. Mow, VC. "The non linear interaction between cartilagedeformation and nteraction fluid flow." *J Biomech* 10 (1977):31-39.
7. Yadav, A.K. and Sushil Kumar. "Synovial fluid flow in reference to animal joints." *Indian Jr Indian stream* 6 (2017).

How to cite this article: Sushil Kumar and AK Yadav. "Behavior of Synovial fluid in a Channel." *J Phys Math* 11 (2020): 320 doi: 10.37421/JPM.2020.11.320