Contact Stress Analysis of Single Row Deep Groove ball bearing (6214)

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Abstract - Bearing is a rotating device which is generally used in engineering device's where the fluctuation of load is occurred such as rolling mills, Gyroscope turbine, Power transmission and some other rolling elements. The failure of bearings occurs due to increase in contact stress. In this paper we find out the numerical value of contact stress at different load with the help of analytical method. We also find contact stress using Ansys and compare both the result. And a graph is plotted between analytical and FEA stress at different loads. In analytical method we calculate the contact stresses by Hertzian contact stress theory and in FEA method we calculate the same. We also calculate deformation by using Hertzian contact stress theory. And compare these stresses with Ansys.

Key words: Hertzian contact stress, inner race, ball, FEA analysis deep groove ball bearing.

I. INTRODUCTION

A unit of bearing having two steel rings each having raceway in which ball and roller are fixed. Balls rotate in this raceway. Load applied on the bearing transfers through the inner ring to outer ring. The load carrying capacity of bearing depends on the geometry of bearing and the type of loading. Mainly radial, axial and combined type loading are applied.

According to Hertzian contact stress theory when two contact surfaces come in contact to each other compressive and tensile stresses produces in the bearing material then deformation occurs and flaking initiates which is primary stage of failure. If this stress continues works on the system then flaking converts into crack.

We are using both analytical and FEA method to calculate the contact stresses. By analytical method the numerical value of contact stresses are not perfect because the frictional effect and contact area of curved surfaces is not known with the change of load between surfaces. For such problems we are also using FEA method to calculate the perfect value. With the help of FEA method we easily know about contact stress, strain which is more important for perfect design of bearing.

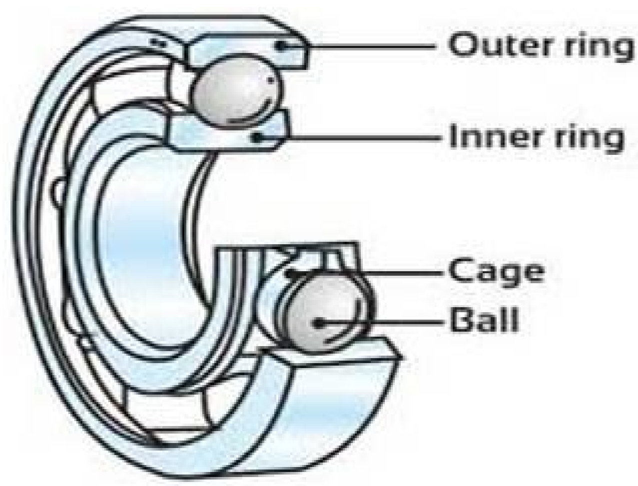

Fig 1.1 Single row deep grove ball bearing

II. PROPOSED METHODOLOGY

Nomenclature: E - Young's Modulus

μ- Poisson Ratio

Material: 52100 chrome steel

Composition of Materials: Mn, C, Mo, Si, Ni, Va

Type of Bearing: 6214 single row deep groove ball bearing.

TABLE 2.1: PROPERTY OF MATERIAL

Young,s modulus of ball (E)	210Gpa
Young,s modulus of race (E)	210Gpa
Poisson ratio of ball (μ)	0.29
Poisson ratio of race (μ)	0.29

TABLE 2.2: GEOMETRIC PARAMETER OF BALL BEARING

Material Type	52100 chrome steel
Bearing type	Sealed
Bore Diameter	70 mm
Outside Diameter	125 mm
Width	24 mm
Inner Race Diameter	84 mm
Outer Race Diameter	117 mm
Number Of Ball	10
Ball Diameter	17.4630 mm
Pitch Diameter	100.5 mm
Groove Radius	9.1mm
Reference Speed	11000 rpm
Limiting Speed	7000

III. SIMULATION/EXPERIMENTAL RESULTS

TABLE 3.1: ANALYTICAL RESULTS OF CONTACT STRESS

Load (N)	Contact stresses by analytical method (MPa)
3000	2119.82
6000	2605.87
9000	3008.48
12000	3340.59
15000	3581.52
18000	3798.70

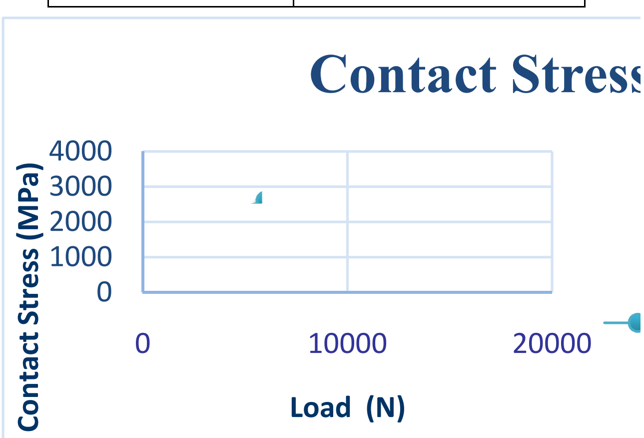

Fig. 3.1 Analytical Results of contact stresses

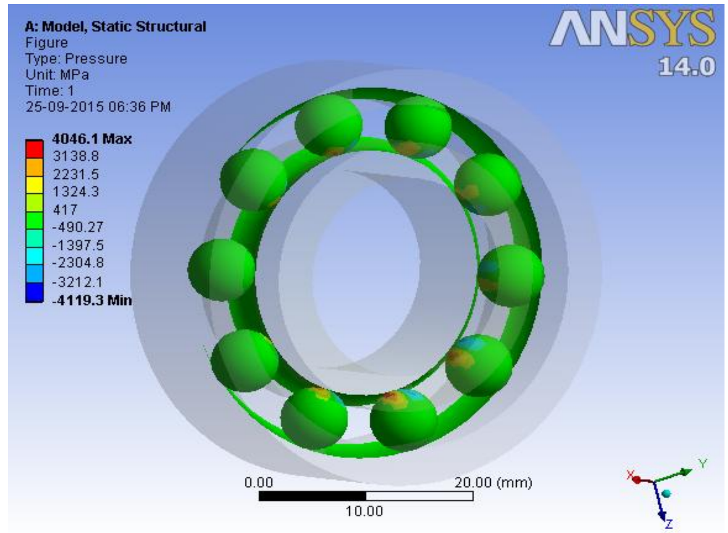

Fig. 3.2 FEA Results of contact stresses : At 18000 N

TABLE 3.2: COMPARISON BETWEEN ANALYTICAL AND FEA RESULT OF CONTACT STRESS

Load (N)	Contact stresses by analytical method (MPa)	Contact stresses by FEA (MPa)	Percentage Error
3000	2119.82	2238.34	5.59
6000	2605.87	2820.14	8.22
9000	3008.48	3228.25	7.31
12000	3340.59	3553.15	6.36
15000	3581.52	3827.52	6.86
18000	3798.70	4067.35	7.07

Fig. 3.3: COMPARISON BETWEEN ANALYTICAL AND FEA RESULT OF CONTACT STRESS

TABLE 3.3 ANALYTICAL RESULT OF DEFORMATION

Load (N)	Deformation by analytical method (MPa)
3000	0.023864
6000	0.037882
9000	0.049640
12000	0.060135
15000	0.069780
18000	0.078799

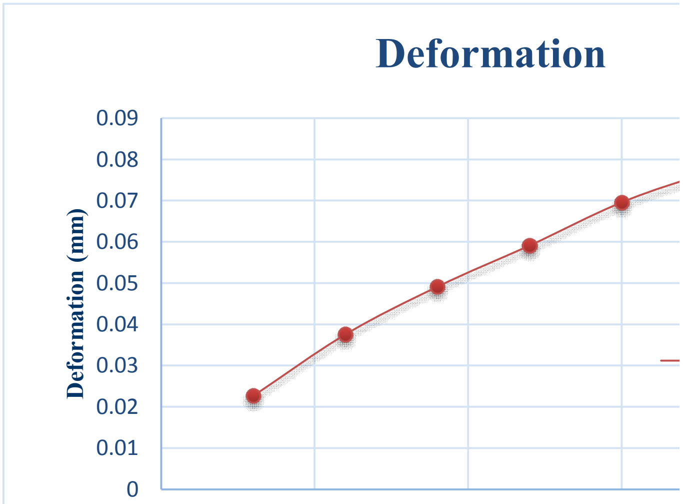

Fig. 3.4 ANALYTICAL RESULT OF DEFORMATION

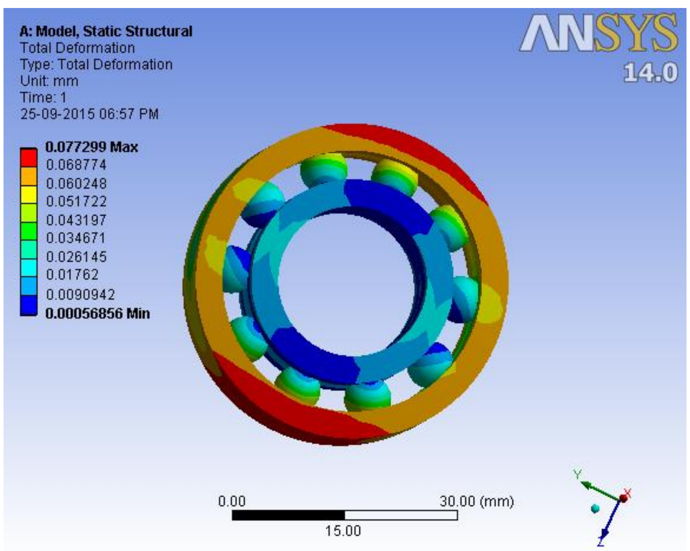

Fig. 3.5 FEA RESULTS OF DEFORMATION: AT 18000 N

TABLE 3.4: COMPARISON BETWEEN ANALYTICAL AND FEA RESULT OF CONTACT STRESS

Load (N)	Deformation by analytical method (MPa)	Deformation by FEA (MPa)	Percentage Error
3000	0.023864	0.022638	5.13
6000	0.037882	0.037545	8.8
9000	0.049640	0.04914	1.0
12000	0.060135	0.059079	1.0
15000	0.069780	0.069569	3.0
18000	0.078799	0.077299	1.9

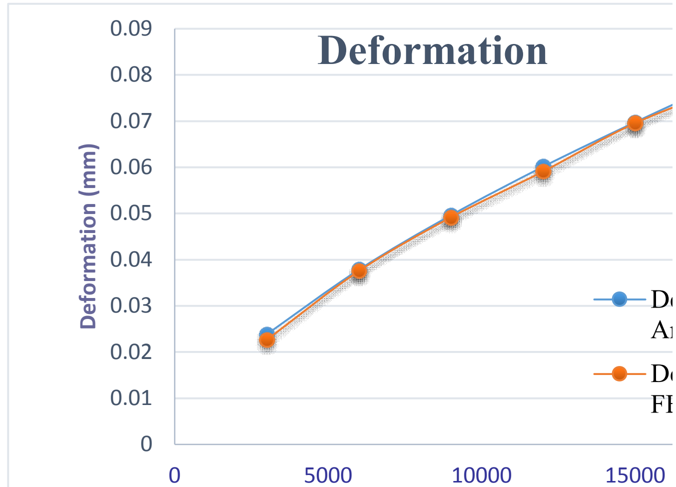

Fig. 3.6 COMPARISON BETWEEN ANALYTICAL AND FEA RESULT OF CONTACT STRESS

IV. CONCLUSION

We calculate the contact stresses and deformation at different load by analytical and FEA method then compare both result which show the behavior of deformation. We calculate the deformation with the help of contact pressure, radius and young modulus. Contact pressure is directly proportional to load and inversely proportional to young modulus of material and poisson ratio.

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