Static Analysis of Spur Gear for Varying Correction Factors and Module

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Abstract**: *The aim of the paper is to find the deflection induced in a spur gear for different correction factors and different modules applied during working conditions. Firstly a standard gear is to be designed for the materials cast iron and sintered steel. The dimensions of the standard gear were determined for various modules using which the modeling was carried out using pro-E modeling software. Similarly the dimensions of the profile corrected gear were also determined for various correction factors. All models were exported to software hyper mesh where the models are meshed properly up to a high degree of accuracy. Then the meshed part is exported to another software ANSYS where analysis part was carried out to get the results. A comparison was carried out theoretically and analytically for cast iron gears are studied for various modules and various correction factors with which we conclude for the optimum method to reduce deflection in gears.***

I Introduction

Gears transmit motion and power between rotating shafts by means of progressive engagement of projections called teeth. We have types of gears like spur, helical, bevel and worm .Spur/Helical gears are used for parallel connection shafts. Here in this paper, a spur gear was used. The materialch used are two different ones for comparison

II Literature Review

[1] Dr.-Eng. Ulrich Kissling,described in his paper, that the type of addendum modification which was used will have a quiet deep influence on the transmission error resu.lts The approach uses an algorithm that included the traditional method for finding out the tooth stiffness in regards to bending and shearing deformation, flattening due to Hertzian pressure by tilting of the tooth in the rigid gear body. **[2]G.Mallesh (et al),** in their paper mentioned that defects can be eliminated by increasing the pressure angle and increasing addendum of mating gears. The radial displacement from the tangential position is termed addendum modification factor or profile shift.**[3] V.Balambica (et al),** mentioned in her paper that due to the problem of interference and undercutting, profile modification or else called addendum modification was carried out. This paper tells about the model, meshing and the analysis techniques using FEA Tool. There has been effort taken to develop the Involute tooth profile including the fillet region by calculating the coordinates using c language.**[4]V.Balambica (et al),** in the paper specified that the stiffness characteristics earlier and deflection of the wheel wes studied to predict the load with respect to time ie the dynamic load.. Here thus tooth was thus assumed to be a short cantilever . But ,this is not the reality.A completely different profile called the involute profile exists in the tooth. Hence ,based on this profile, work was carried out and ,the stiffness characteristics wes carefully studied from the analysis results An improvement was thus made. It was proved that Finite element analysiswas one such tool , that can be used for predicting dynamic loads acting on gear tooth. **[5] P.B.Pawar (et al),** In this work metallic gears of steel alloy and Aluminium silicon carbide composite have been manufactured. Efforts have also been carried out for modeling and finite element analysis of gears using ANSYS 14.0. Composite gears offer improved properties over steel alloys and these can be used as better alternative for replacing metallic gears. **[6] S.Mahendran (et al.),** in their paper designed the spur gear to study the weight reduction and stress distribution for cast steel and composite materials. To study the impact analysis for cast steel and composite materials. Finally, comparing and analyzing of the composite gear with existing cast steel gear was done. **[7] Ravichandrapatchigolla (et al),** A finite element modeling approach was developed for determining the effect of gear rim thickness on tooth bending stresses in large spur gears. **[8] M.Keerthi (et al),** In this paper,the spur gear was modeled .Static stress analysis was carried out to determine the deflection and von mises stresses.

Revised Manuscript Received on April 15, 2019.

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The results were validated with theoretical calculations by Lewis equations. The Analytical part was carried out by considering different materials for gears like structural Steel,Gray Cast Iron ,Aluminium alloy and epoxy E glass , all sintered materials, composite material etc , The results were then compared.On comparison results found ,it was stated thatthat the FEM models represent a very important step in the related studies of deviations. **Dr.H.G.H Van Melick[12]** in his paper investigates steel and plastic gear transmission using numerical finite element and analytical methods to study the influence of stiffness of the gear material on the bending of the gear teeth. The change in the load sharing also changes the stresses **TH.Costopoulous et.al[13]** proposed several tooth alternative design for increasing the load capacity.

III.Spur Gear Design

A.For Steel :

Young’s Modulus E=2.1×10^5 N/mm^2
Bending stress σb=210 N/mm^2

B.For Sintered Steel:

Young’s Modulus E=1.37×10^5 N/mm^2
Bending stress σb=290 N/mm^2

IV Analysis:

A.Figure 1 represents the loading details of the pinion loading &displacement of different modules & different materials of the standard gear in the following table

B.Figure 2 represents the pinion Displacement of same module for various correction factorsIn the analysis part, onetoothwas taken into consideration and the load applied at the pitch circle. Since the pinion tooth experiences mor eload, hence pinion tooth was considered.We can see the comparison made for cast iron and sintered steel.. This was carried out for all the modules.In the later part the analysis was carried out, keeping module as constant and varying the correction factors. The shape of the tooth could be seen varying for different correction factors. As the correction factor was increased, the load carrying capacity of the tooth also increases.The displacement and stress results were plotted..

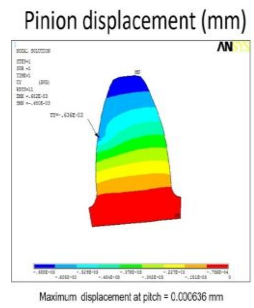

Fig 1.1 shows the pinion displacement of cast iron (c14) for module m=9

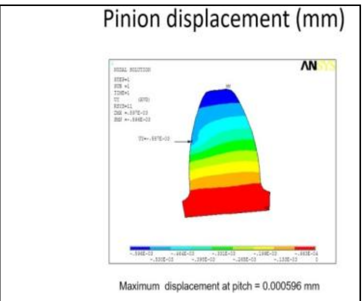

Fig 1.2 shows the pinion displacement of sintered steel for module m=9

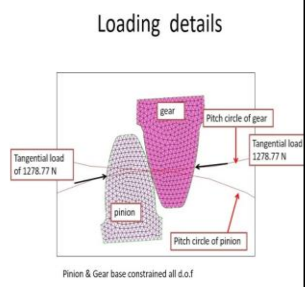

Fig 1.3 Loading details of cast iron (c14) For different modules

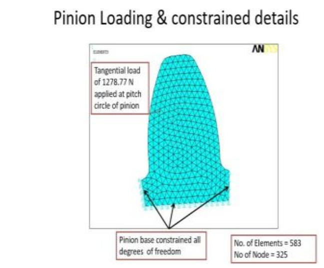

Fig 1.4 Pinion loading of cast iron (c14) for different modules

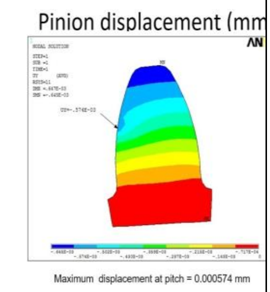

Fig 1.5 shows the pinion displacement of cast iron (c14) for module m=7

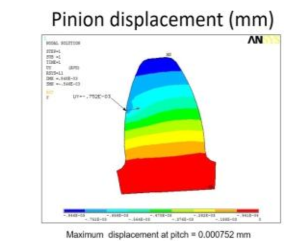

Fig 1.6 shows the pinion displacement of sintered steel for module m=7

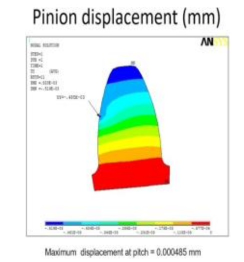

Fig 1.7 shows the pinion displacement of cast iron (c14) for module m=8

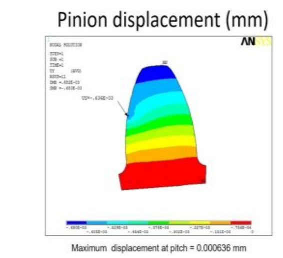

Fig 1.8 shows the pinion displacement of sintered steel for module m=8

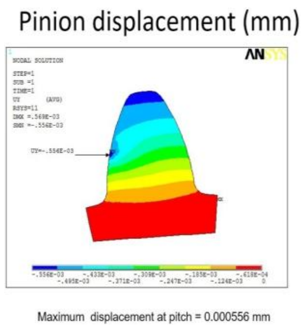

Fig 2.1 shows the pinion displacement of cast iron (c14) for module m=7 with correction factor =0.2

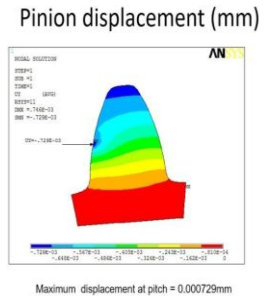

Fig 2.2 shows the pinion displacement of sintered Steel for module m=7 with correction factor =0.2

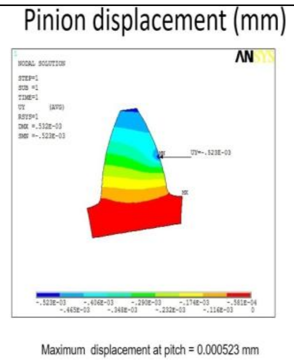

Fig 2.3 shows the pinion displacement of cast iron (c14) for module m=8 with correction factor =0.4

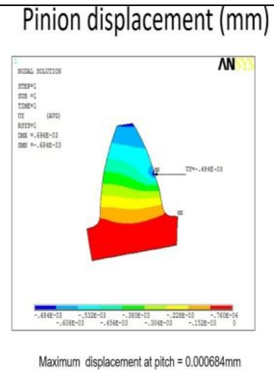

Fig 2.4 shows the pinion displacement of Sintered steel for module m=8 with correction factor =0.4

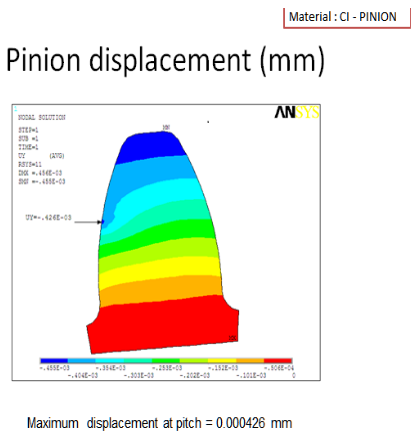

Fig 2.5 shows the pinion displacement of cast iron(c14) for module =9 with correction factor =0.9

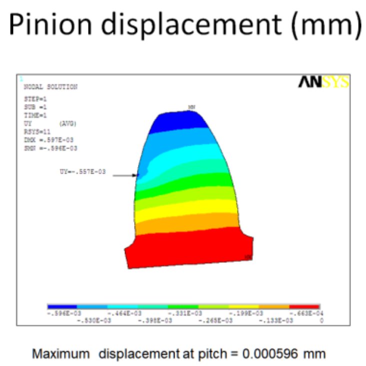

Fig 2.6 shows the pinion displacement of sintered Steel for module =9 with correction factor =0.9

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V PERCENTAGE VARIATION FOUND IN THE ANALYSIS:

Table.1(A)

Pinion Displacement	m=7	% Variation	m=8	% Variation	m=9	% Variation
C14	Theoretical= 0.0005454 FEM = 0.000574	5.24%	Theoretical= 0.000477 FEM = 0.000485	1.67%	Theoretical= 0.000444 FEM = 0.000426	4.05%
Sintered Steel	Theoretical= 0.00071593 FEM = 0.000752	4.79%	Theoretical= 0.0006264 FEM = 0.000636	1.59%	Theoretical= 0.00058327 FEM = 0.000596	2.18%

Table 1 shows the value of theoretical &analytical displacement values for different modules for a standard gear

Table.2(B)

Table 2 shows the values of displacement results of same module for different correction factor

Correction Factor	Displacement Results	
	C14	Sintered steel
0.2	0.000556	0.000729
0.4	0.000523	0.000684
0.6	0.000484	0.000683

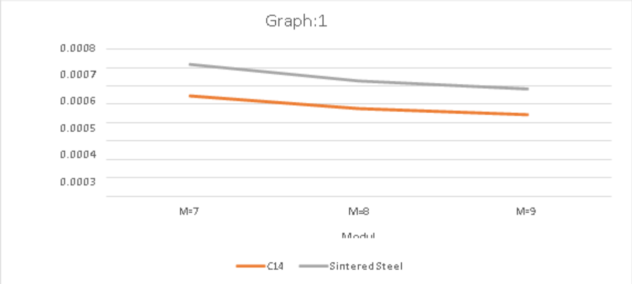
Table.3(C)

Correction Factor	Stress Results	
	C14	Sintered steel
0.2	0.0000717	0.0000941
0.4	0.0000577	0.0000756
0.6	0.0000506	0.0000663

Table 3 shows the values of stress results of same module for different correction factor

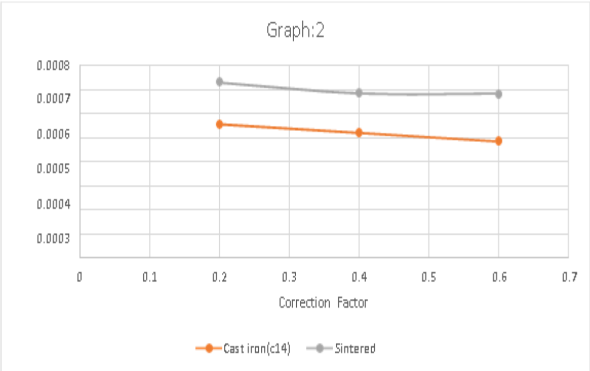
VI GRAPHICAL PRESENTATION

Graph1:(A)



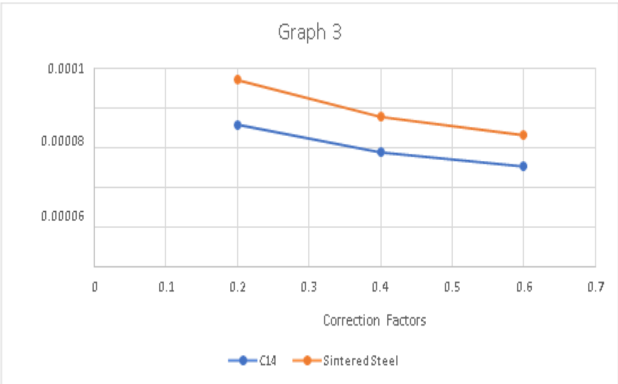
Graph 1 represents the theoretical displacement results for different module & different material of Standard gear

Graph:2:(B)



Graph 2 represents the analytical stress for different modules &different materials of standard gear

Graph:3:(C)



Graph 2 represents the stress results for same modules with different correction factor

VII CONCLUSION

From the table, it was seen that the theoretical and analytical results for value comparison were just 5% which was accepted. Hence FEA is a confirmed tool which can be used to study the analysis using the correct form of tooth profile. On comparison of deflection results with the cast iron gear, its seen that the deflection was slightly found to be higher for that of an sintered gear. Even the stress was found more. It is concluded that, this is due the density of the powdered materials being low and the strength being less when compared to cast iron. So we can increase the porosity and density for the sintered gear and again on further analysis, we can get less deflection and stress.

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