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Defect Analysis Of Spur Gear Box ForStructural Health Monitoring

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Abstract—Vibration is the blight of any machine tool industries which creates improper surface finish of the work piece. In this project, an attempt has been made to analyze high speed gearbox used in high speed machining for vibration characteristics under dynamic conditions. Analytical calculations are carried out to arrive at the dimensions of gearbox based on the desired speed ratio. Withthe help of time history, mesh frequency spectrum and its harmonics, the dynamic response of high speed gearbox is studied through multi body analysis. Modal analysis andcritical speed of the high speed gearbox are carried out through simulating software for flexible bodies. Based on theresults, the design modifications are carried out to avoid resonance**.**

KEYWORDS—GEARBOX, VIBRATION, FEA, ANSYS.

I INTRODUCTION

Vibration is one of the major limitations or disadvantagemachining operation, which causes improper surface finish of the work piece. Vibration started from various sources such as misalignment, imbalance, improper tightening, motor, tool flattering, spindle movement, improper foundation and dynamics of gearbox. Vibration from any one of these leads toimproper surface finish. The surface finish of the work piece also depends upon the feed rate, cutting depth and cutting speed. Surface finish of thework piece depends upon feed rate, depth of cut and rotating speed of the work piece. Due to various machining operation the gearbox is subjected to wide speed ranges and torque variations. [8]

In lathe machine studies related to vibration controlling is presented. Studies about to effect of gear mesh fluctuations on dynamics of spur gearbox are presented. When meshing of gears the dynamics of the gearbox change the internal dynamics force.Same way, studied about detection and identification of sources of vibration of machine tool is carriedout. The studies related toinfluence of cutting parameters on machine tool vibration and surface finish is presented in Frequency response analysis of a gearbox is carried out. The external load variation and its response on the vibration characteristics are studied. Studies related tothe influence of mesh stiffness in controlling the vibration of spur gears pair is carried out. Although vibration studies have received good attention, the present project focuses in on dynamics of high speed gearbox where gear meshing frequency, modalanalysis and critical speed are analyzed.

In its simplest form, a geared spindle system is modeled asa couple of spindle representing the gear mesh. While thedisks are considered to be rigid the shafts are subject totorsional vibration. [1] However, the lateral vibrations due to flexure may not be neglected if the shafts are compliant The vibration problem then becomes a combined flexural- torsional-mesh vibration problem. The system where one of the shafts was taken as rigid making it a three degree of freedom system. The response dueto geometric eccentricity and mass unbalance was determined and the compliant effect of the gear mesh was ignored in their model.

single stage geared rotor bearing system has been used to study a variety of aspects by imposing various boundary conditionson this system. The bearings were modeled as rigid bearings, while in, the bearings were modeled as pinned supports. As mentioned in, modeling the bearings in a rotor system as pinned supports would generally be unacceptable in a real world situation. However, the qualitative nature of the results is not affected by this assumption. It has the advantagesof simplified modeling and therefore, eases of interpreting the results while having responses similar to a real geared rotor system

II LITERATURE REVIEW

Ian Howard et al. In this paper aims to searching the effectiveness of using the torsional vibration signal as a diagnostic tool for planetary gearbox faults detection. The traditional way for condition monitoring of the planetary gear uses a stationary

transducer mounted on the ring gear casing tomeasure all the vibration data when the planet gears pass by with the rotation ofthe carrier arm.
However, the time variant vibration transfer paths between the stationary transducer and the rotating planet gear modulate the resultant vibration spectra and make it complex. Torsional vibration signals are theoretically free from this modulation effect and therefore, it is expected to be much easier and more effective to diagnose planetary gear faults using the fault diagnostic information extracted from the torsional vibration.[1]

J. Parra et al. Planetary gearboxes are important components of many automobile applications. Vibration analysis can increase their life and prevent expensive repair and safety. However, an effective analysis is only possible if the vibrationfeatures of planetary gearboxes are properly known. In paper, models are used to study the frequency of planetary gearbox vibrations under fault and non fault condition. Two different models are considered: phenomenological model, Results of model not directly compared, because the phenomenological model provides the vibration on a fixed radial direction, such as the measurements ofthe vibration sensor mounted on the outer part of the ring gear.[2]
Chao Liu a et al. In this paper introduces an improved model generated by hybrid user-defined element method (HUELM) for dynamic analysis of a double-helical gear reduction unit. instructural dynamics and system dynamics, the model have four developed elements with simulate the gear pair, bearings, flexible shafts and the housing. A closed-loop test rig is validate the model: an encoder-based method to measure vibration acceleration of the gear pair, and accelerometer- based measurement systems are employed to obtain the dynamic responses of the housing. later, two additional models by the finite element method(FEM) and the lumped mass method (LMM) are constructed for numericalcomparison to illustrate the HUELM's substantial ad- vantages. Compared with the LMM, the HUELM is of capacity to investigate the interaction among the subsystems; moreover, it is more efficient than the FEM primarily because of the integrated tooth contact analysis method and loaded tooth contact analysis method. It is demonstrated that the predictions by the HUELM match well with the experimental data in termsof meshing frequencies and vibration responses. It is also concluded from the numerical comparison that the HUELM is appropriate for dynamic analysis, particularly of large complex transmission equipment.[3]
Xintao Jiaoet al. Wind turbine gearboxes generally exhibit complex vibration characteristics due to wide variations in the operating conditions, and dynamics of the structure coupled with flexible supports. Conventional spectral analysis method maynot provide reliable health monitoring and fault diagnosis of the gearbox. In this study, a novel order tracking method based ondiscrete spectrum correction technique is proposed toanalyze wind turbine gearbox vibration for the purposes of health monitoring and fault diagnosis. The effectiveness and robustness of the proposed method are demonstrated through simulations and engineering tests. The results show that the shaft rotating speed could be accurately identified from the vibration signal together with amplitudes of significant gear meshing components. Modulation sidebands of both the planetary and fixed-shaft gears in ahealthy wind turbine gearbox were further analyzed, which revealed inherent shaft misalignment in the fixed-shaft gear.[4]

Zhipeng Feng et al.Torsional vibration signals are theoretically free from the amplitude modulation effect causedby time variant vibration transfer paths due to the rotation of planet carrier and sun gear, and therefore their spectral structure are simpler than transverse vibration signals. Thus, it is potentially easy and effective to diagnose planetary gearbox faults via torsional vibration signal analysis. they give equations to model torsional vibration signals, considering both distributed gear faults and local gear faults and derive the characteristics of traditional Fourier spectrum and the roposed demodulated spectra of amplitude envelope and instantaneous frequency. These derivations are not only effective to diagnose single gear fault of planetary gearboxes, but can also be generalized to detect and locate multiple gear faults. they validate experimentally the signal models, as well as the Fourier spectral analysis and demodulation analysismethods.[5]
Barshikar Raghavendra Rajendra Even though there is lot of condition monitoring and analysis techniques, researchers aresearch or investigate simple methods for gearbox , which is an important power transmission component in any machinery. Ingearboxes, load fluctuations on the gearbox and gear defects are two major sources of vibration. Further, at times, measurement of vibration in the gearbox is difficult because ofthe inaccessibility in mounhting the vibration transducers. Techniques such aswear and debris analysis, vibration

monitoring and acoustic emissions require accessibility to the gearbox either to collect samples or to mount the transducers on or near the gearbox. But dusty environment, background noise, structural vibration etc. may hamper the quality and efficiency of these techniques. Hence, there is a need to monitor the gearbox away from its actuallocation, which can be achieved through Motor current signature analysis (MCSA). An efficient and new but non intrusive method to detect the fluctuation in gear load may be the motor current signature analysis (MCSA). Motor current signature analysis (MCSA) has been the most recent addition as a non-intrusive and easy to measure condition monitoring technique. Thisanalysis system can be used for measuring the characteristics for a perfectly working gearbox and use the data as a standard for measuring faults and defects in other gearboxes.[6]

M. Kreidl [7]et al. Condition monitoring systems are very important for researchers in gearbox development. They enabledetection of gear cracks during testing, and stop the testbefore the gear crack progresses. Then the researchers are ableto recognize where the crack began and to decide about the reason for the gearbox fault. Consequently, the designers can take appropriate steps in gearbox design to improve gearbox performance. Condition monitoring systems deal with various types ofinput data, for instance vibration, acoustic emission, temperature, oil debris analysis etc. Systems based on vibration analysis, acoustic emission and oil debris are the most common and are very well established in industry. Systems based on acoustic emission have a more obvious application for bearing monitoring than for gearing monitoring. However some applications forgearbox condition monitoring have been introduced. Acoustic emission (AE) is usually defined as transient elastic waves generated from a rapid release of strain energy caused by a deformation or by damage within or on the surface of the material

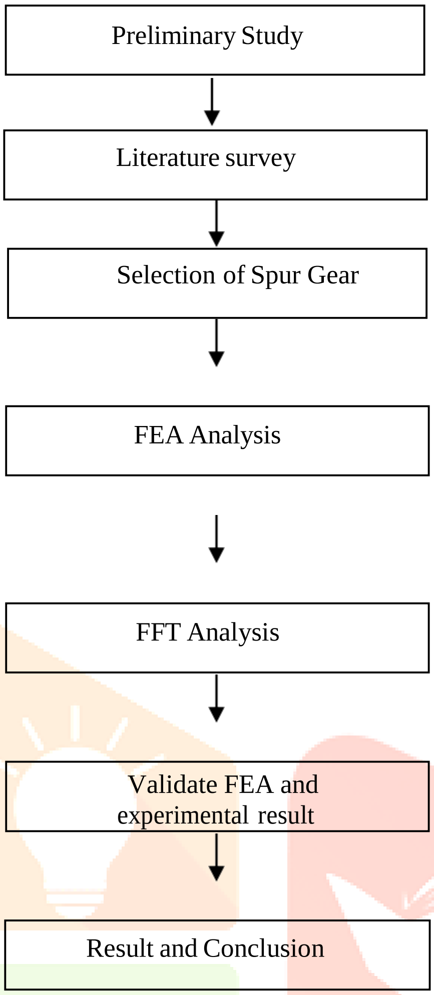
PROBLEM DEFINATION

We cannot see crack detection in gears visually. So to detect the gear wear the vibration analysis technique is used.this technique it is not necessary to mount the system on gears. Wecan mount the accelerometer on the gearbox system and we can measure frequency of gear condition the wear rate of gear.This system is more efficient than other.

OBJECTIVES

1. To prepare CAD design of spur Gear box usingCATIA V5.
2. To study vibration analysis of spur Gear box
3. To perform modal analysis of spur Gear box by usingFEA
4. To perform experimental study of spur Gear box byusing FFT analyser. To validate FEA and experimental result

III METHODOLOGY



In Methodology Firstly primary study of vibration of gear box literature survey of paper Then selection of spur gear box which teeth, length are decided as model requriment, After that FEA analysis with the help of ansys software and then FFt analysis In an experimental procedure gearbox is allowed to run at its rated power and speed by applying different load conditionson is used. We take spur Gear box with motor 300r.p.m,spur gear which are normal,with crack,and missing teeth.we use Ansys.For vibration measurements magnetic base accelerometer is placed on the top just below the locationof bearing in axial and radial direction of gearbox.By making all above arrangements readings are taken for healthy gear and good lubrication condition. This data is stored in FFT analyzer for further analysis.

Vibration spectrums are taken for gears having various faults and the data is stored in computer for further analysis. For different condition of faults & different load conditions data is collected

IV. VIBRATION ANALYSIS

Vibration analysis consists in listening inside the machine. Each component vibrates differently and generates a characteristicnoise that leaves a typical fingerprint in the spectrum in the form of a linear pattern. If damage is present, the pattern stands outfrom the noise floor. This allows the specialist to recognize, for example, whether the problem comes from unbalance, misalignment or bearing damage. In addition to an accurate diagnosis it is generally also possibleto determine whether urgent action is necessary or whether it can wait until the next scheduled servicing

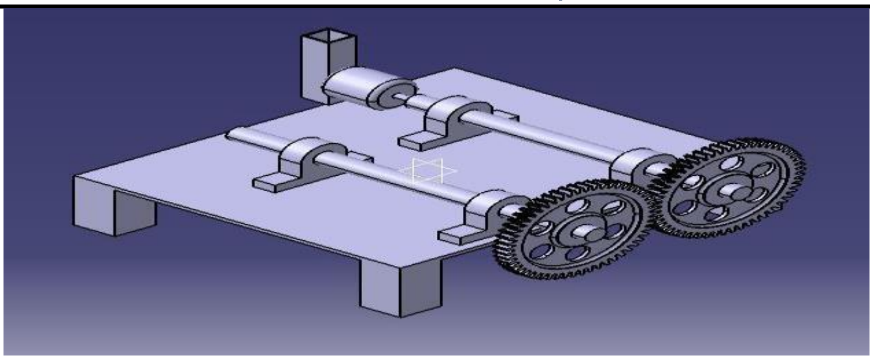


Fig.No.1 CATIA Model of Spur Gear Box

In spur gear box there are 50 teeth taken length of assemblywhich is 300*350mm,Radius of of gear are 10mm,length ofshaft is 330 mm ,dia is 20mm,the missing teeth there are 1teeth are missing which is seen, In motor specified 300rpm We are taking This spur gear box dry condition are present

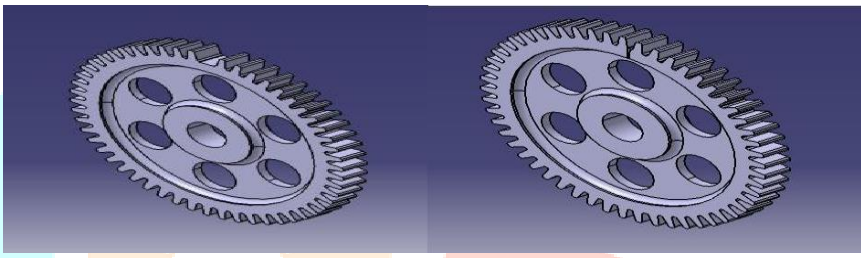


Fig No.2 A. Missing Teeth

B. Crack Of Spur Gear

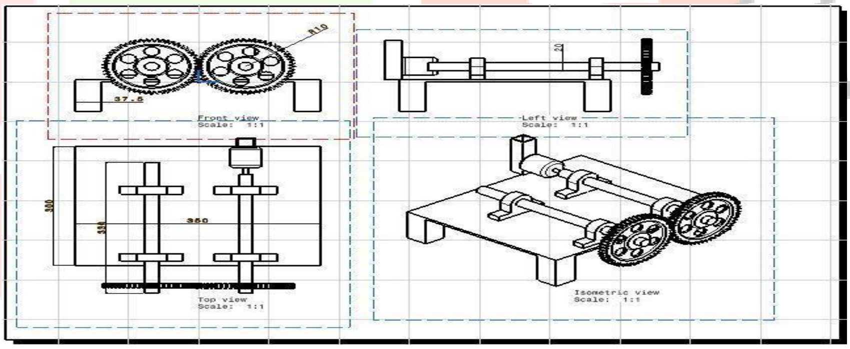


Fig.No.3 Drafting Of Spur Gear Box Geometry

GEOMETRY:

Fig shows Geometry of spur gear with no faults or healthy in ansys software there are 50 teeth

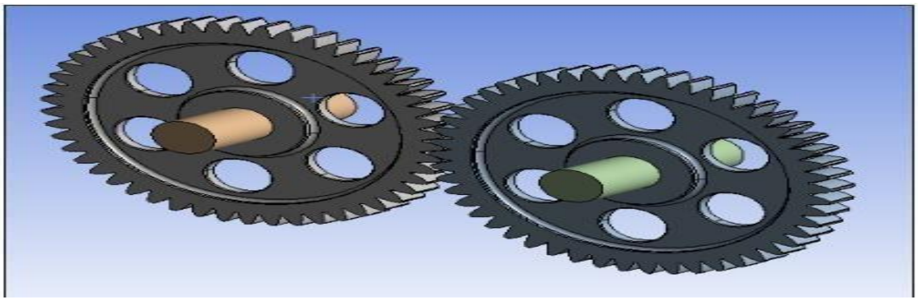


Fig.No.4.Geometry with Normal of Spur Gear

CONTACTS:

Fig shows contacts of spur gear which is contact region b and c are showing

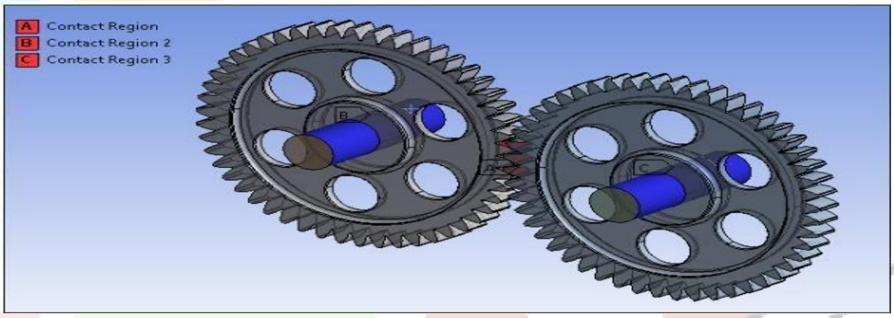
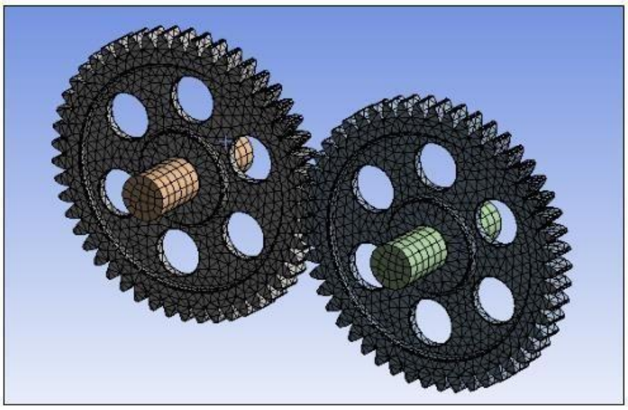


Fig.No.5 Contacts of Spur Gear

MESH:

The next step is meshing of Gear box which contain Nodes and element shown



Statistics	
Nodes	72322
Elements	38676

Fig.No.6 Meshing of Spur Gear Box

BOUNDARY CONDITION:

For boundary condition gear are fixed on shaft and motion aregiven to the gear

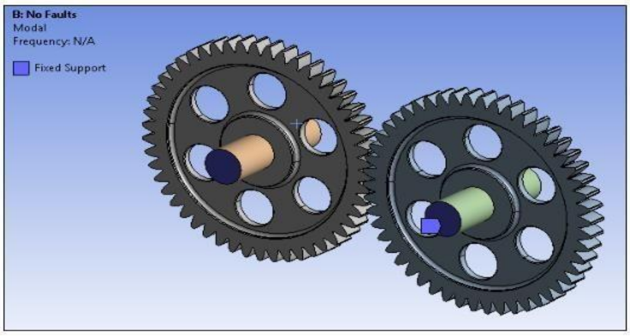
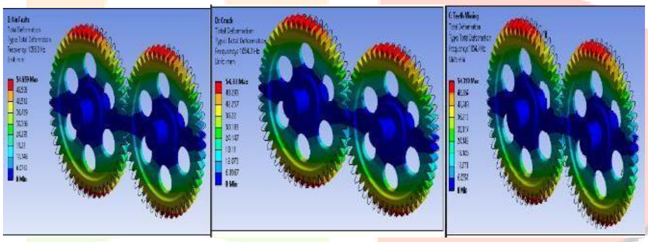


Fig.No.7 Boundary Condition of Spur GearBox

TOTAL DEFORMATION:

In ths first deformation of Normal with crack,and missing teeth result as Mode 1,2,3,4,5 shown which is increasing inbelow table In crack condition crack present in at the near teeth of of spur gear which is 4 mm crack

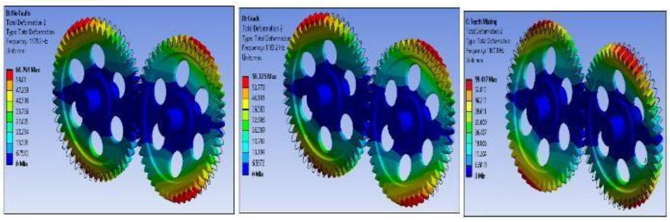
Mode1: In mode 1frequency of these condition are increasedshown in table no1



NORMAL GEAR WITH CRACK MISSING TEETH

Fig.No.8 Total Deformation of Mode 1 SpurGear Box

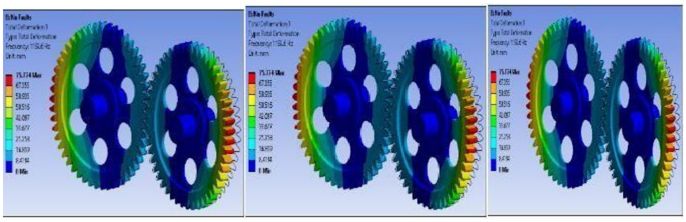
MODE 2:



NORMAL GEAR WITH CRACK MISSING TEETH

Fig.No.9 Total Deformation of Mode 2 Spur Gear Box

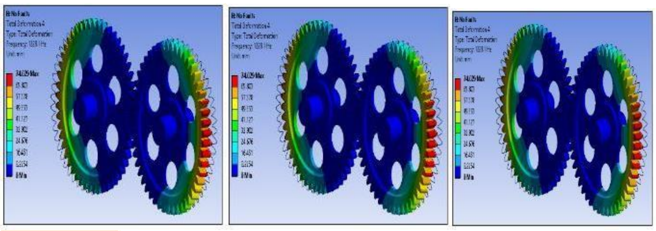
MODE3:



NORMAL GEAR WITH CRACK MISSING TEETH

Fig.No.10 Total Deformation of Mode 3 Spur Gear Box

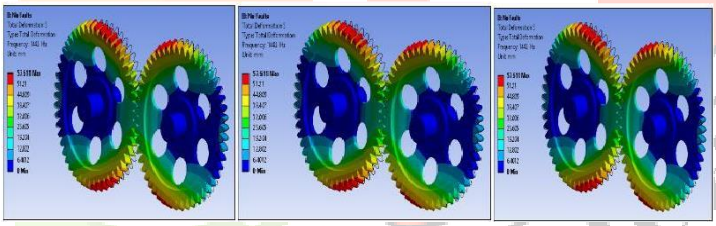
MODE4



NORMAL GEAR WITH CRACK MISSING

Fig.No.11 Total Deformation of Mode 4 SpurGear Box

Mode 5



NORMAL GEAR WITH CRACKMISSING TEETH

Fig.No.12 Total Deformation of Mode 5 SpurGear Box Table No.1 FEA results of Normal,with crack,missing teethgear

Mode	Gear with Normal	Gear with crack	Gear with Missing teeth
1	1054.3	1054.7	1056.8
2	1163.2	1167.8	1179.3
3	1185.7	1188	1192.6
4	1226.1	1227.3	1228.1
5	1409.6	1431.9	1442

Table shows different mode and frequency for normal gear, with crack on gear and missing teeth of gear which increased ascompared to healthy or normal condition so it conclude there are some problem in gear box

V. EXPERIMENTAL RESULTS

FFT ANALYSIS

FFT is one main property in any sequence being used in general. To find this property of FFT for any given sequence, manytransforms are being used. The major issues to be noticed in finding this property are the time and memory management. Twodifferent algorithms are written for calculating FFT and Autocorrelation of any given sequence. Comparison is done between the two algorithms with respectto the memory and time managements and the better one is pointed. Comparison is between thetwo algorithms written, considering the time and memory as the only main constraints.Time taken by the two transforms in finding the fundamental frequency is taken. At the same time the memory consumed while using the two algorithms is also checked. Based on theseaspects it is decided which algorithm is to be used for better results

DEWE-43 UNIVERSAL DATA ACQUISITION INSTRUMENT

When connected to the high speed USB 2.0 interface of any computer the DEWE-43 becomes a powerful measurement instrument for analog, digital, counter and CAN-bus data capture. Eight simultaneous analog inputs sample data at up to 204.8kS/s and in combination with DEWETRON Modular Smart Interface modules (MSI) a wide range of sensors are supported Voltage Acceleration Pressure Force Temperature Sound Position RPM Torque Frequency Velocity And more The included DEWESoft application software adds powerful

measurement and analysis capability, turning the DEWE-43 into a dedicated recorder, scope or FFT analyzer.

Fig.No.13 Experimental Setup of FFT Analyser

VI. RESULT AND CONCLUSIONTEST FFT RESULTS

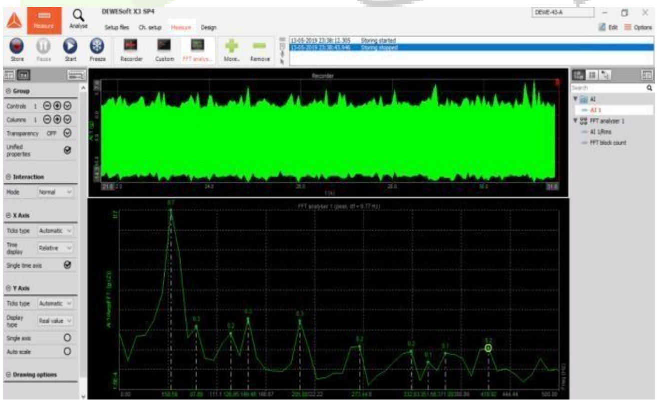


Fig.No.14 Testing Result of Normal Spur Gear

In Fig shows FFT Results which shows Normal spur gear which can be noted in Table no 2 this frequency has normal gearor healthy gear

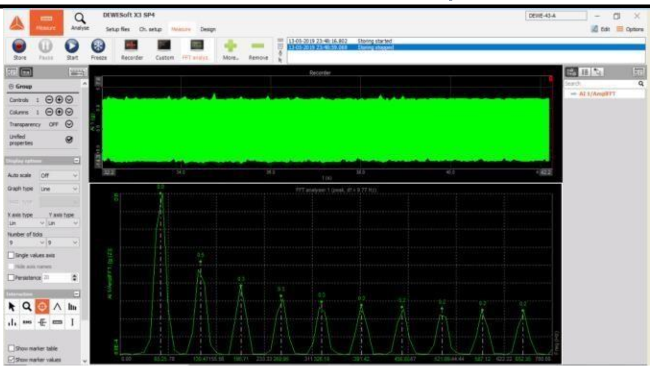


Fig.No.15 Testing Result of Spur Gear WithCrack

In Fig 15 FFT result of crack of spur gear which frequency areincreased as compared to the normal gear as mension in tableNo.2

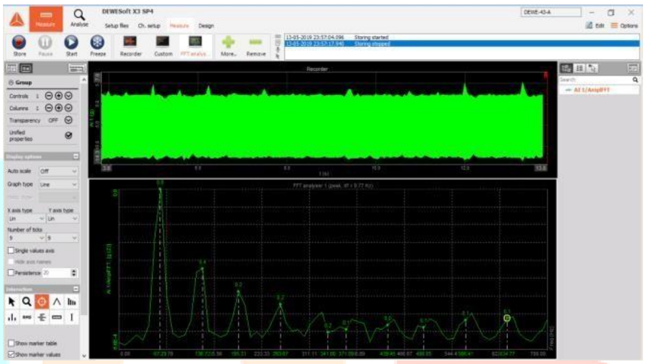


Fig.No.16 Testing Result Of Spur Gear With Tooth Missing

In fig 16 shows that FFT test results of tooth missing of spur Gear which has frequency are increased as compared bothNormal and crack gear so there are some problem in gear box

Table.no.2 Frequencies of Normal,crack,missing Teeth Spurgear by FFT reading

FFT Reading	Frequency for normal spur Gear	Frequency for crack spur Gear	Frequency for missing teeth sour gear
1	58.59	65.25	67.29
2	87.89	130.47	136.72
3	126.95	195.71	195.31
4	146.48	260.95	263.67
5	205.08	326.11	341.80
6	273.44	391.42	371.09
7	332.03	456.65	439.45
8	351.09	521.89	498.05
9	371.09	557.12	566.41
10	419.91	652.35	634.77

From the result in fft analyser frequency which compared tonormal spur Gear or heathy Gear to crack of spur gear andmissing teeth of spur Gear increasing so there are some problem with gear box

VII .VALIDATE FEA AND EXPERIMENTAL RESULT

In FEA There are modal analysis get natural frequencies which can doing impact hammer test .Then we take fft analysetestwith the help of accelerometer which placed on bearing for crack and missing teeth which frequencies are changed so we detectthere are problem in gear box.

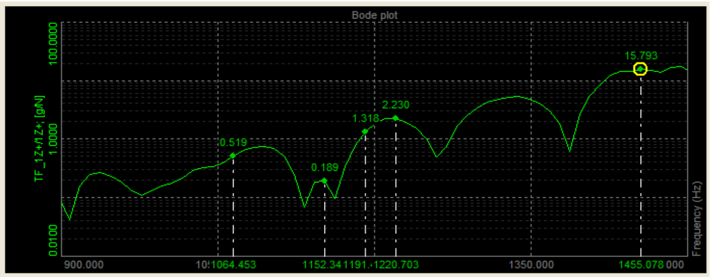


Fig No.16 Validate Fea And ExperimentalResult Table No.3 Validate Fea And ExperimentalResults

MODENO	NORMAL SPUR GEAR (FEA)	CRACK SPUR GEAR (FEA)	MISSING TEETH spur gear (FEA)	FFT TEST
1	1054.3	1054.7	1056.8	1064.45
2	1163.2	1167.8	1179.3	1152.34
3	1185.7	1188	1192.6	1191.00
4	1226.1	1227.3	1228.1	1229.7
5	1409.6	1431.9	1442	1455.07

In Table Validation of Fea result and experimental result which can be frequencies are changed so we detect there areproblem in gear box

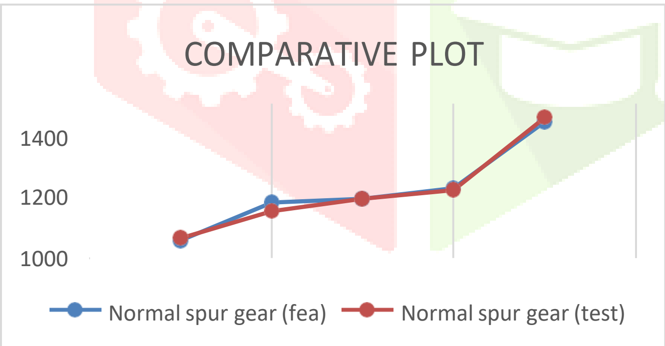


Fig No 17.Comparative Plot of FEA and FFT

VIII. CONCLUSION

1. Model Frequency from FEA and FFT analyzer are in good relationship.
2. FEA result are in good relationship with testing result in terms of Natural Frequency.
3. The monitoring of health of gearbox is easy due to variations in natural frequencies at mid and higher frequenciesthe comparative graph between the normal gear, gear crack &gear tooth missing is drawn.
4. From this graph we will see that the frequencies obtained forall these ones are different.from this we can conclude thatthe there is problem in the gear box which we are using

REFERENCES

1) Song Xue, Ian Howard,"Torsional vibration signal analysis as a diagnostic tool for planetary gear fault detection",Departmentof mech engg,curtin university of technology,GPO Box U1987,Perth WA6845,Austrelia,19July2017.

2) J. Parra, Cristián Molina Vicuña,"Two methods for modeling vibrations of planetary gearboxes including faults:Comparison and validation",Laboratorio de vibracionesmecanicas,Universidad de conceppcions Edmundo Larenas 21,chile.1Feb2017.

3) Chao Liu a ,Zongde Fang a, Feng Wang,"An improved model for dynamic analysis of a double- helical gear reduction unit by hybrid user-defined elements: Experimental and numericalvalidation"school of mech engg,northwestern polytechnical university,Xian710042,china.2018

4) GuolinHe,Kang Ding, Weihua Li, XintaoJiao,"Anovel order tracking method for wind turbineplanetary gearbox Vibration analysis based on discrete spectrum correction technique" school of mechanical,southchina,universityoftechnology,gaung zhou 510640,Pr china,19Oct2015.

5) Zhipeng Feng, Ming J. Zuo,"Fault diagnosis of planetary gearboxes via torsional vibration signal analysis" school ofmech engg,university of science and technology Beijing,100083,china,2012

6) BarshikarRaghvendra Rajendra*,Sntash V. Bhaskar"Condition Monitoring of Gear Box by Using Motor Current Signature Analysis".Researchscholar,MechdepartmentS.R.E.C. O.E,Kopergaon, pune university,ISSN2250-3153,Aug 2013

7) M.Kreidl,R Smid,P,Vecer,"Condition Indicators for Gearbox condition Monitoring Systems",Czech technical university in prague,ActaPolytechnica45,6/2013.

8) Virupaxayya Hiremath,Nitin venkataram,'vibration characteristics of High speed Gear box through Dyanamicanalysis"mechanical and manufacturing department,Banglore560058,India.2016