Vibration analysis of electric grass trimmer using FEM

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Abstract— *HAV(Hand Arm Vibration)is a major problem in workers who operates hand held machine in day to day life, Hand arm vibration is form of vibration that is transmitted into your hands and arms, usually as a result of carrying out mechanized, hand-held work tasks. In this experiment the test RIG is manufactured to give comfort as well as help in reduction for Vibration, this rig also isolated by trimmer using MR elastomer and Foam and all readings are taken by FFT and validated by FEA.*

Keywords— HAV-Hand Arm Vibration, FFT-Fast Fourier Transformer, MR Elastomer-Magneto Rheolaogical.

I. INTRODUCTION

The Indian Farmer while Working on Field he has to put all effort into field. The farmer always needed to reduce effort, while cutting grass on field there is Vibration. The important thing is that the vibration which is available in grass Trimmer/Cutter affects the Hand of operator who is operating; prolonged use of electric grass trimmer exposes the user to the risk of hand-arm vibration syndrome. A simple approach for the suppression of hand-arm vibration in electric grass trimmer is presented. The proposed system is a Modal analysis and operating deflection shape analysis of the electric grass trimmer were carried out and It is designed and fabricated for testing. The results in some previous experiment indicated that minimum vibration level was related to the position of the System on the shaft and reducing Hand Arm Vibration on electric grass trimmer. The result has to take from modal analysis and operating deflection shape which has to reveal that the presence of Vibrations has successfully reducing or not. The Vibration has to take in all Axis i.e. X,Y,Z. There are other way that reduce vibration by Isolating System from operator by means of Gloves or Providing Damping to the system.

II. GRASS TRIMMER

The Grass trimming is usually carried out with the use of petrol engine or electric motor powered trimmer which uses a rotating nylon string to cut the grass. The use of petrol engine is subjected to emission regulation which limits their application. The US Environmental Protection Agency (2010) has adopted new regulations for small engines (operate at or below 19 kW) that are widely used in lawn and garden area. Electric models produce no emissions at the point of use.

FIG 1 ELECTRIC GRASS TRIMMER WITH RIG

The application of electric grass trimmer for maintenance of grass compound in places where emission is regulated. The electric grass trimmer usually employs an AC electric motor of 400 W with the plastic rotating head coupled directly to the motor. A single nylon string is attached to the rotating head. The single string construction of the electric grass trimmer made it a rotationally unbalanced which resulted in high level of vibration. Under this condition the user is exposed to hand-arm vibration (HAV). Extensive exposure of HAV can lead to a series of vibration induced disorder in the vascular and nonvascular structures in human hand-arm therefore two string cutter is used in this paper.

III. EXPERIMENTAL MODAL ANALYSIS

In the Experimental Model Analysis, we will make fast response functions (FRFs) with FFT analyser, modal excitation techniques and modal parameter. Experimental modal parameters (Natural frequency and amplitude) are obtained from a set of FRF measurements. All the tests were performed at the J.T.Mahajan College Of Engineering, in the Civil engineering lab.

Experimental Setup Consists of

1. A-2 channel FFT analyzer to compute vibration in grass trimmer.
2. Laptop as a Display unit for FFT Analyser
3. Upper and lower accelerometers attached to handle.

3.1 FFT Analyser

FFT Analyser is used to measure the frequency range of grass trimmer in which the grass trimmer subjected to various length with various isolator gives different conditions with amplitude. This will help us in designing the trimmer with different length where the vibration is less and which material is perfect isolator to rig.

3.2 Display unit for FFT Analyser

This is mainly in the form of PC (Laptop) when the excitation occurs due to the electric grass trimmer then the signals transferred to the portable PULSE and after conversion comes in graphical form through the software. Mainly the data includes graphs of frequency Vs amplitude, frequency Vs time resonance frequency etc.

FIG 2 FFT ANALYSER

3.3 Experimental set up:

3.3.1 Procedure for Experimental Setup by using FFT Analyzer

- First of all electric grass trimer is fixed in rig assembly which is fabricated,to reduce vibration & give comfort to the operator.
- The connections of the FFT analyzer, laptop, and accelerometer sensors along with the requisite power connections were made with electric grass trimmer.
- The accelerometers were fixed at the handle of electric grass trimmer.
- Then excitation starts as electric grass trimmer is started and the vibration from motor to shaft is transmitted to handle.
- Then in electoral grass trimmer handle on X Y & Z axis amplitude Vs frequency graph was obtained from graphical user interface.
- By moving the cursor to the peaks of the FFT graph, the cursor values and the resonant frequencies were recorded.
- The above procedure is repeated for various length & isolators used in experiment and natural frequencies are measured.
- The values (i.e., amplitudes) obtained from the FRF spectrums were compared with respect to all axis and isolator material.

3.3.2 Construction And Testing

The experimental set up consist of portable dead channel FFT, electric grass trimmer with rig, laptop and two accelerometers (one placed near or on the vibration exciter and other on top on mass pan).The electric grass trimmer with rig was used in this study. Prior to the start of the experiment the whole set up of electric grass trimmer with rig is connected with FFT and was ran for 10 min. means at which condition resonance occurred. The electric grass trimmers when operated then vibration actuated in grass trimmer are measured in FFT software.

In experiment the amplitude of grass trimmer in various condition with various isolators material are taken are as follow

- Amplitude in short & long length.
- Amplitude on various axis.

Amplitude with holding to grass trimmer & without holding grass trimmer

Different length used are

- The short length for the shaft is taken as 00 mm
- The longer length for shaft is 966.84 mm

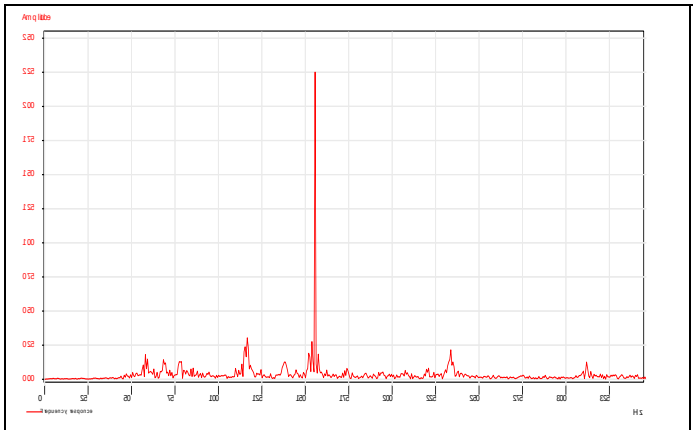
Setup for FFT grass trimmer

The following figures are shows the Condition of holding

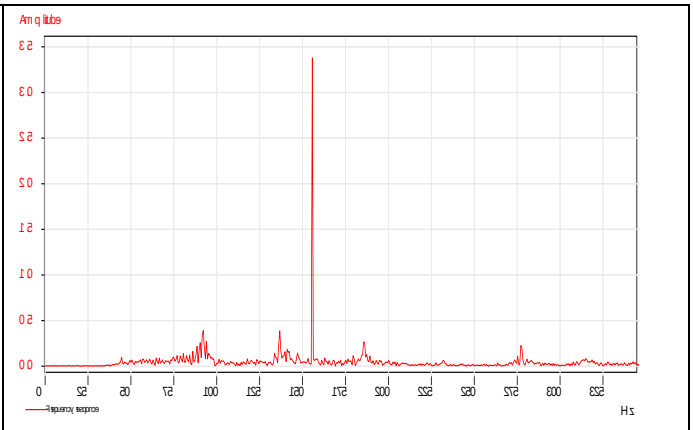
FIG 3 THE SET UP WITH HOLDING GRASS TRIMMER

TABLE 1
THE RIG WITHOUT ISOLATION MATERIAL

	The RIG without isolation material			
1	Length	Condition of hold trimmer	amplitude (volt)	frequency (Hz)
	short length	with grip	2.25	155.64
	long length	with grip	3.37	155.64



Short length with grip

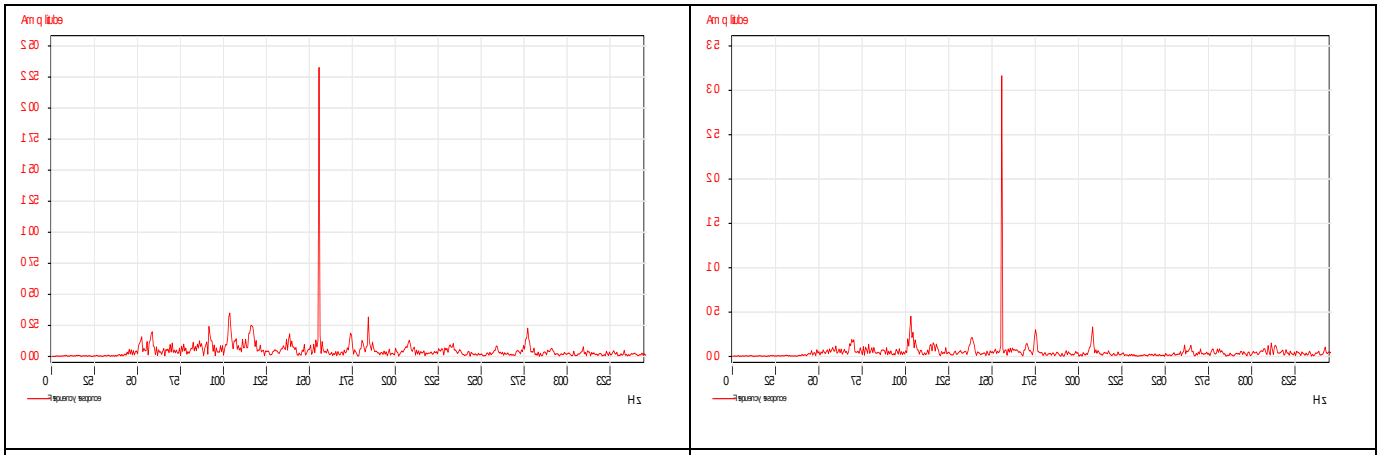


Long length with grip

GRAPH 1 THE RIG WITHOUT ISOLATION MATERIAL

TABLE 2: THE RIG ISOLATED WITH FOAM

	The RIG isolated with foam			
2	Length	Condition of hold trimmer	amplitude (volt)	frequency (Hz)
	short length	with grip	2.19	155.64
	long length	With grip	3.09	155.64

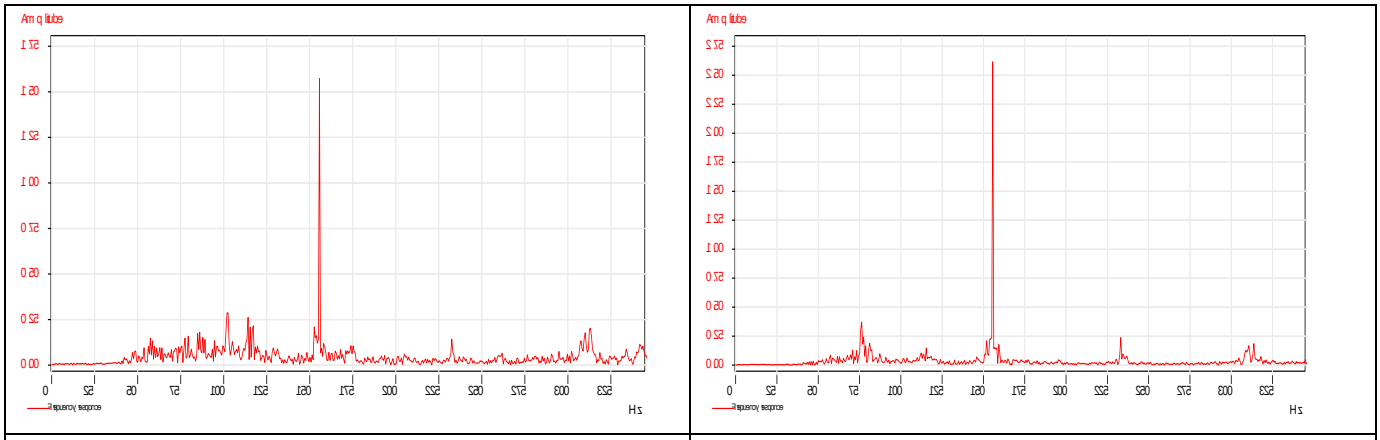


Short length with grip | Long length with grip

GRAPH 2 THE RIG ISOLATED WITH FOAM

TABLE 3: THE RIG ISOLATED WITH MR ELASTOMER

	With MR elastomer			
3	Length	Condition of hold trimmer	amplitude (volt)	frequency (Hz)
	short length	with grip	1.51	155.64
	long length	with grip	2.55	155.64



Short length with grip | Long length with grip

GRAPH 3THE RIG ISOLATED WITH MR ELASTOMER

IV. MODEL ANALYSIS BY FEM

4.1 Preprocessing

The trimmer is drawn in Pro-E

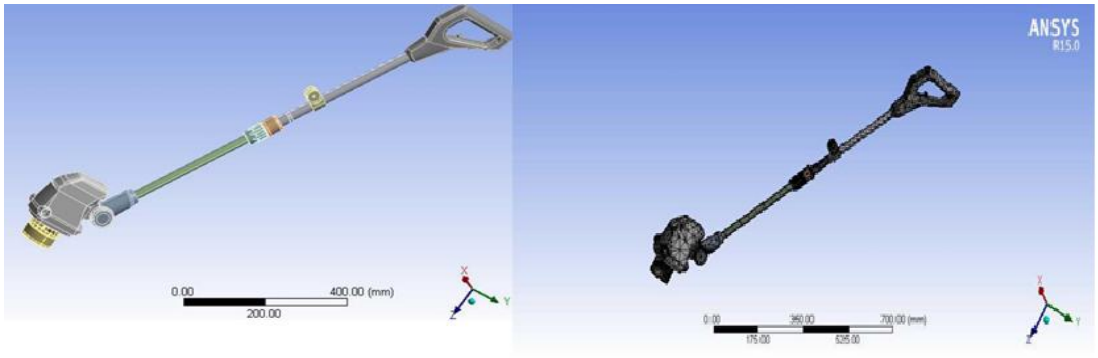


FIG 4 GEOMETRIC MODEL OF GRASS TRIMMER IN PRO-E MESHED ELECTRIC TRIMMER IN ANSYS 15.0

4.2 Post processor

The Meshing is done in Ansys

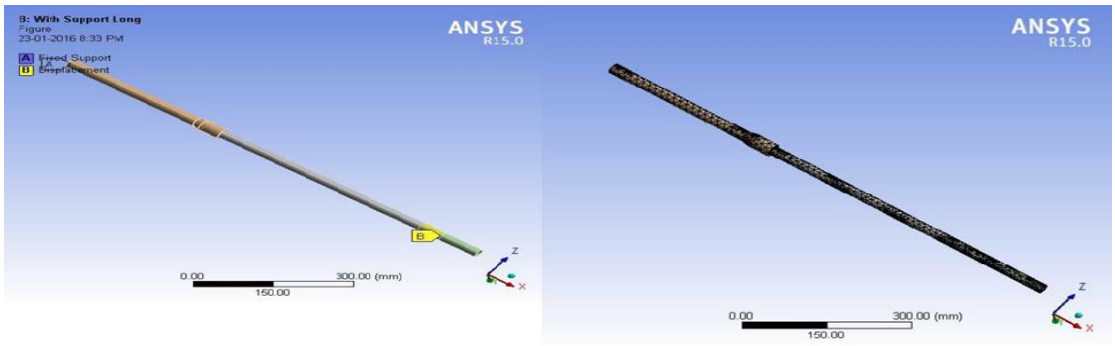


FIG 5 THE ELECTRIC TRIMMER HAS FOLLOWING CONSTRAINED ON ROD

4.3 Result of ansys

The various condition ANSYS figure are shown below

With support MR Elastomer long

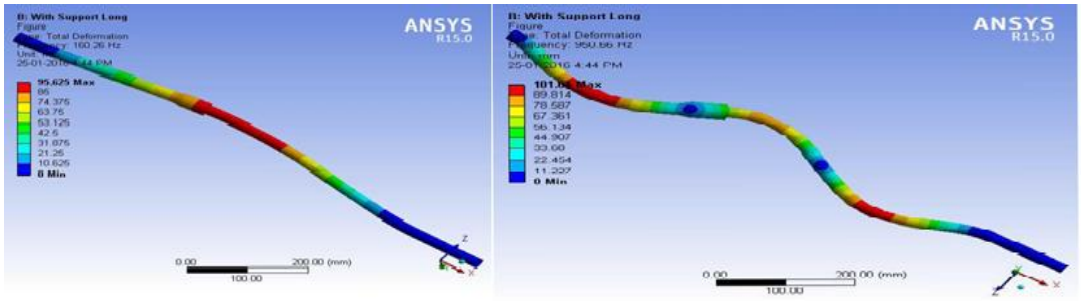


FIG 6 MR ELASTOMER WITH SUPPORT LONG LENGTH

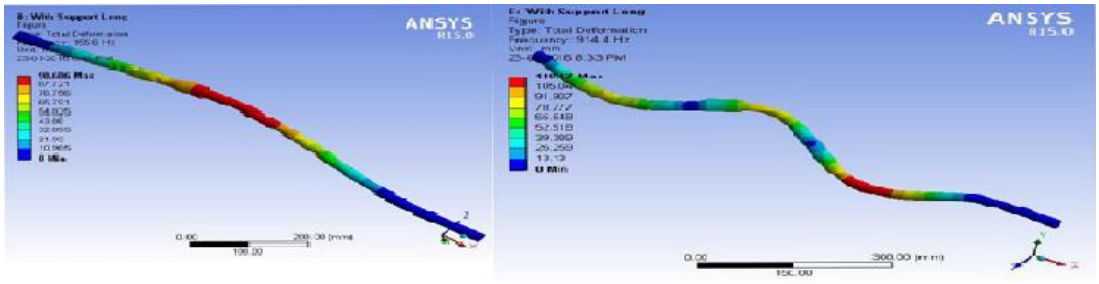


FIG7 FOAM WITH SUPPORT LONG LENGTH

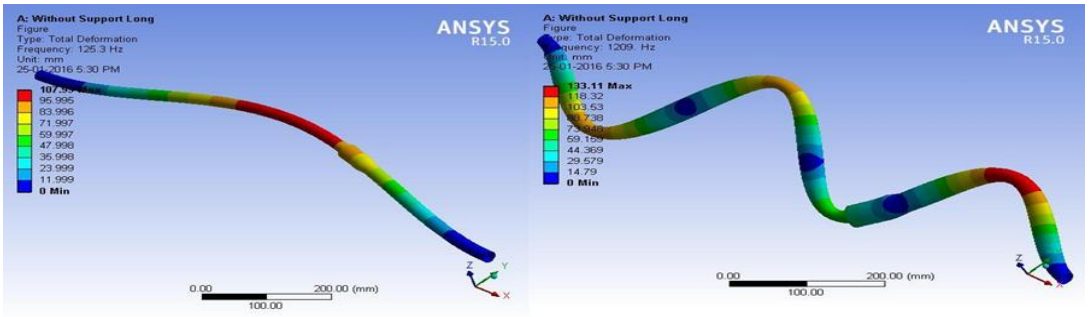


FIG 8 WITHOUT ISOLATOR WITH SUPPORT LONG LENGTH

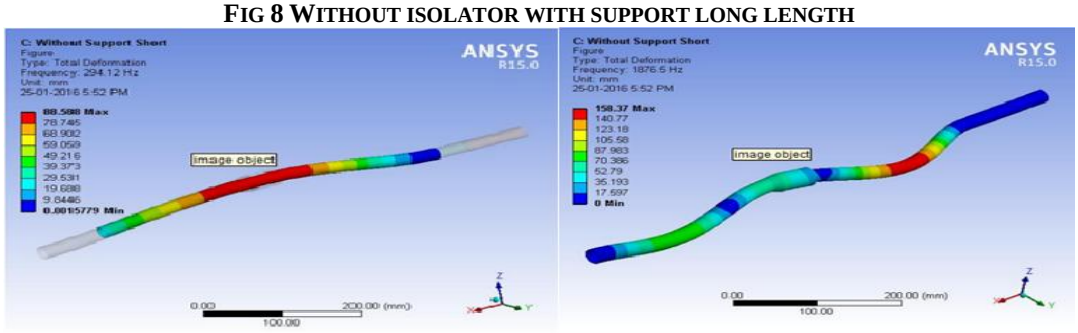


FIG 9 WITH MR ELASTOMER WITH SUPPORT SHORT LENGTH

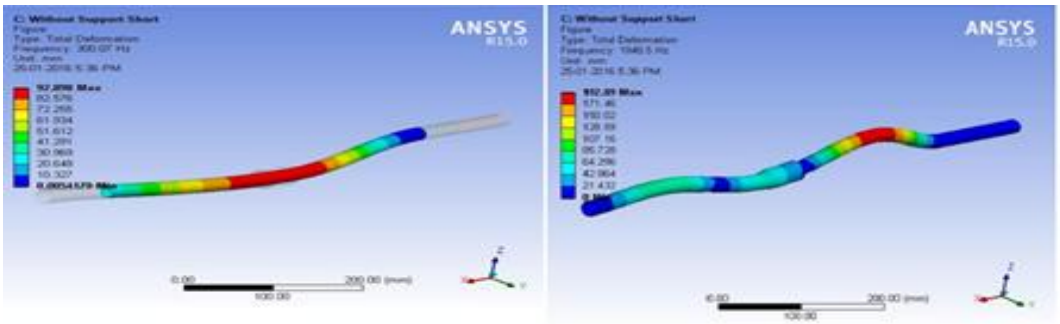


FIG 10 WITH MR ELASTOMER WITH SUPPORT SHORT LENGTH

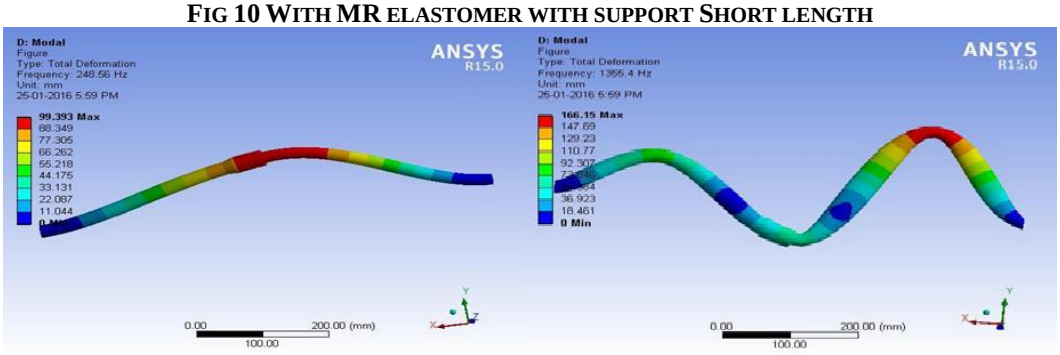


FIG 11 WITHOUT ISOLATOR WITH SUPPORT SHORT LENGTH

V. CONCLUSION

Mode	With support Elastomer long	With support Elastomer short	With support foam long	With support foam short	With support long Without isolator	Without support short
1.	156.61	294.12	154.45	300.07	125.33	248.56
2.	160.26	320.81	155.6	307.48	368.42	256.15
3.	476.19	903.85	502.49	945.28	790.31	780.4
4.	486.92	917.07	511.96	962.28	790.47	796.69
5.	915.72	1833.1	896.63	1931.2	1209.3	1355.4
6.	950.66	1876.5	914.4	1946.5	1267.2	1365.3

From above table it is seen that the natural frequency in ansys and Harmonic frequency of FFT is matched in Long length, where these length get matched then at that point resonance is high therefore the long length is not suited for Garss trimmer in project with any isolator. The Short length eith MR Elastomer is most preferable than Foam and without isolator.

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