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Detection of Internal cracks in exhaust tailpipe using FFT Analyzer

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Abstract: Any structure used for a particular application has to bear the stresses acting upon it. Earlier, when any structure failed, it had to be replaced by another structure having the same strength and characteristics. But today, due to the excessive competition in Market, the time consumed for the trial and error methods is much more and is directly proportional to loss. Hence, to avoid these kind of circumstances, we have different techniques to find flaws in structures used for different applications.In this paper, the internal cracks detection in a tailpipe is carried out using FFT Analyser inorder to check the strength and compatibility of the structure and ensure proper working of the system.

Keywords:-Exhaust tailpipe, internal cracks, FFT Analyzer.

I. INTRODUCTION

Exhaust tailpipe is primarily used to reduce the noise levels to acceptable standards as per the norms. It is also used for transporting high pressure exhaust gases leaving the engine away from the driver’s compartment. In this paper, the tailpipe of an automobile exhaust system having four bends is used as a specimen to check whether there are any internal cracks present. Tube bending is one of the most frequently used fabrication techniques for stainless steels. When a metallic pipe is bent, two things happen. The outside wall reduces in thickness, due to the stretching of the material, and the inside wall become thicker. In other words the material that forms the outside is stretched, while the inside bend is compressed. Due to this there is change in grain structure of the material. As a effect of this, natural frequency of also changes.The presence of the internal cracks due to any reason can be harmful as these can propogate further and can harm the system.Thus, detection of internal cracks in an automobile exhaust tailpipe is carried out in this paper.

II. DEFINITIONS

1) Natural Frequency : If a system is disturbed and allowed to vibrate on its own, the frequency with which it vibrates without damping and without external forcing is known as its Natural frequency.
2) Spectrum Analyzer: A spectrum analyzer is an instrument which measures the magnitude of an input signal versus frequency within the full frequency range of the instrument. The primary use is to measure the power of the spectrum of known and unknown signals. [2]
3) FFTAnalyzer: The Fast Fourier Transform spectrum analyzer uses digital signal processing techniques to provide in depth waveform analysis with greater flexibility. [2]
4) Bending process: Bending refers to the operation of deformation of a specimen around a straight axis where the neutral plane lies. [3]

III. FFT SPECTRUM ANALYZER

A FFT spectrum analyzer is a clever set of operations implementing Fourier’s basic theorem. In the Fast Fourier Transform spectrum analyzer digital signal processing techniques are used to provide in depth waveform analysis of signal waveform spectra with greater flexibility than other methods[2].Similar to digitizing oscilloscope, the input signal is digitized to high sampling rate and the resulting time recorded is then mathematically transformed into a frequency spectrum using Fast Fourier Transform Algorithm.

Fig.1. FFT Analyzer

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Advantages:

1.The entire spectrum takes only 4ms to measure. Hence, speed is the main advantage.
2. It is able to capture non-repetitive events.
3. Able to analyze signal phase.[2]

SPECIFICATIONS OF THE PIPE

Fig.2. Exhaust tailpipe.

Material :Aluminum coated Steel pipe.
Dimensions :50.8 X 1.6 mm

TABLE

Tensile Test	Results
Yield Strength	212.17
U.T.S	313.04
Elongation	33.20%

Table 1: Properties of material.

EXPERIMENTAL SETUP

A typical measurement setup for experimental modal analysis consists of three constituent parts. The first part is responsible for generating the excitation force and applying it to the test structure, the second part is to measure and acquire the response data and the third part provides the signal processing capacity to derive FRF data from the measured force and response data. For experimental modal analysis of silencer impact hammer is used for giving excitation to the silencer. An accelerometer used has a magnetic base and is located at the end of the silencer. The FFT spectrum analyzer is used to analyze the data.

With the use of the above equipments experimental test setup is prepared. The impact is given at the end of silencer by using impact hammer. Analyzer receives analog voltage signals from the accelerometer. The analyzed signals used to find natural frequencies and mode shapes in graphical form with the use of software installed in the computer. The graph of acceleration verses frequency for impact test is shown in figure.

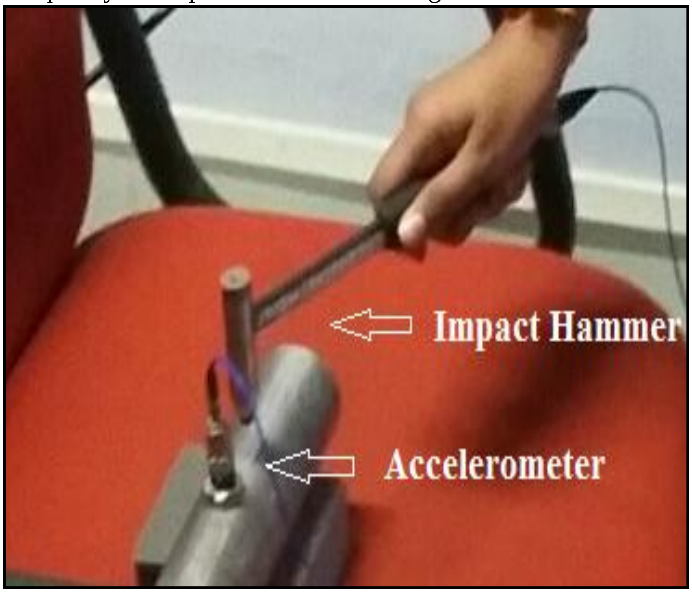

Fig. 3. Position of impact hammer and accelerometer

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EXPERIMENTAL ANALYSIS OF EXHAUST PIPE

Fig.4. Exhaust pipe with markings at 100mm intervals.

Sample of pipe of 1800mm length having diameter 50.8 mm is taken whose natural frequency is to be determined. Asthe pipe is bent using bending machine, the wall thickness of the pipe is changed. This pipe was placed on well cushioned surface to avoid unwanted vibration from the surface. Initially, the pipe was marked after 100mm to check natural frequency of the pipe throughout the length. Then using FFT analyzer, the sensor was placed on each marking and readings were obtained for different parts of pipe.The readings obtained are described below:

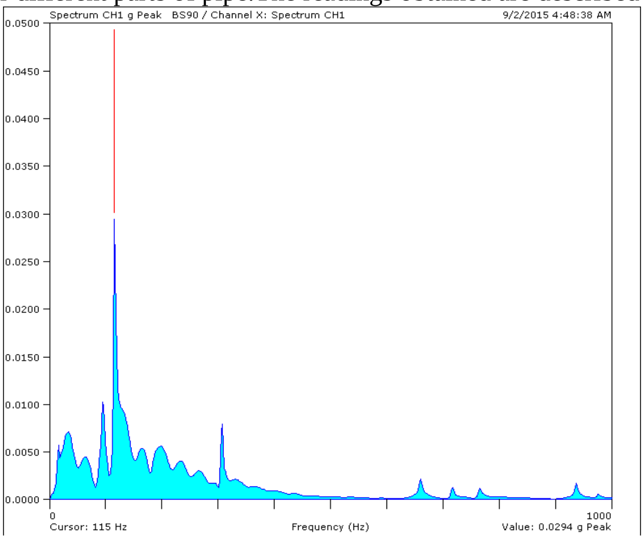

Fig.5. Spectrum at all positions except at 300mm.

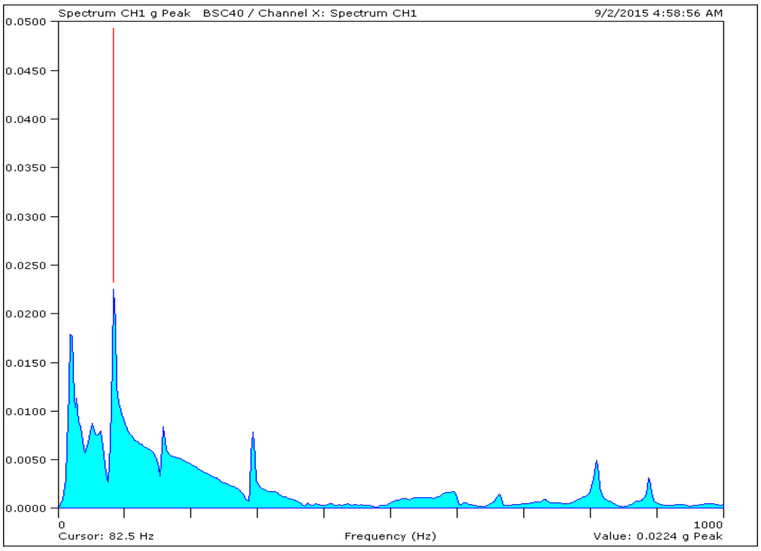

Fig.6. Spectrum at location 300mm.

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EXPERIMENTAL ANALYSIS

Sr. No.	Distance	Frequency
1.	100mm	115 Hz
2.	300mm	85.2 Hz
3.	600mm	115 Hz
4.	1200mm	115 Hz
5.	1800mm	115 Hz

RESULT

It is observed from the above table that the natural frequency is 115Hz at almost all the locations but it reduces to 85.2 Hz at 300mm location.

IV. CONCLUSION

As we know that any change in the structure is responsible for the change in the natural frequency of that structure. From the experimental analysis we can conclude that the natural frequency of the exhaust pipe changes near one location i.e 300mm which gives us the indication of presence of some internal cracks in that region.

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