A Comparatively Analysis of Vibration Signal Using Genetic Algorithm And DWT Methods

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Abstract- *Our proposed work is analyzing of two different algorithm GA and DWT in MATLAB software. In this work used inbuilt data set in MATLAB software for multistory building form of move mental forces criteria. Now this data is G+10 multi storey building on standard RCC material. Hence investigation of this research work compare both method in form of Vibration detection Noise minimization and Performance histogram curve following parameters.*

Keywords- Damage Identification; Reinforced Concrete building; Wavelet Analysis; Structural Monitoring.

I. INTRODUCTION

Some common sources of ground-borne vibration are trains, buses on rough roads, and construction activities such as blasting, pile-driving and operating heavy earth-moving equipment:

- Ground borne vibration can be a serious concern for nearby neighbour of a transit system route or maintenance facility, causing buildings to shake and rumbling sounds to be heard. It is unusual for vibration from sources such as buses and trucks to be perceptible, even in locations close to major roads. The vibration being produced by the traffic propagated through the foundation of the floors and walls of a building will create resonance frequencies to the building. Hence, it will produce perceptible vibration, rattling of items such as windows or dishes on shelves, or a rumble noise. This will create the room surfaces act like a giant loudspeaker causing so called ground-borne noise. It will make the occupants in the building felt uncomfortable with the sounds in the room. Ground borne vibration is a creation of man-made over decade ago due to the developments of road, highway and rail networks. Vehicles move on the road and the train on the railways will produce vibration to the ground. The vibration will propagate through the ground and into buildings, resulting in uncomfortable vibration and unacceptable levels of noise in the building. This is clearly investigated at the Wellington Hospital in London.
- The building lies directly above two mainline railway tracks and within only a few meters of four underground railway tunnels and the main road. The problem related to this matters are the multiples sources of vibration produced by the train and cars propagates along the surfaces of the ground, and influenced the internal noise and vibration.

II. OBJECTIVE

- To identification of vibration of sandwich beam and wall in G+10 building.
- Observation of signal parameters like as noise, vibration signal strength, standard deviation etc.
- Improvement of vibration signal strength quality.
- Comparison between Two different algorithms for sandwich beam vibration detection.

III. OPTIMIZATION AND SANDWICH ERROR MINIMIZATION TECHNIQUE

In mathematics, optimization is the selection of a best element under some constraints from some set of available solutions. Optimization problem consists of maximizing or minimizing a real function by systematically choosing input values from within an allowed set and computing the value of the function. The generalization of optimization theory and techniques to other formulations comprises a large area of applied mathematics. More generally, optimization includes finding "best available" values of some objective function given a defined domain or a set of constraints. Types of optimization techniques are discussed below.

Classical optimization techniques:

The classical optimization techniques are useful in finding the optimum solution or unconstrained maxima or minima of continuous and differentiable functions. These are analytical methods and make use of differential calculus in locating the optimum solution. The classical methods have limited scope in practical applications as some of them involve objective functions which are not continuous and/or differentiable. Yet, the study of these classical techniques of optimization form a basis for developing most of the numerical techniques that have evolved into advanced techniques more suitable for today's practical problems.

These methods assume that the function is differentiable twice with respect to the design variables and the derivatives are continuous.

Three main types of problems that can be handled by the classical optimization techniques are:

1. Single variable functions
2. Multivariable functions with no constraints,
3. Multivariable functions with both equality and inequality constraints. In problems with equality constraints the Lagrange multiplier method can be used. If the problem has inequality constraints, the Kuhn-Tucker conditions can be used to identify the optimum solution.

These methods lead to a set of nonlinear simultaneous equations that may be difficult to solve.

IV. DISCRETE WAVELET TRANSFORM

The wavelets are mathematical relations that examine the data corresponding to the resolution or scale. They help in the study a signal at distinct resolutions in distinct windows. For example, if the signal is visualized in a prominent window, the gross characteristics may be noticed, but if they are visualized in a smaller window, only small items can be noticed.

The wavelets offer certain advantages compared to Fourier transforms. For example, they are doing a good job in the estimation of signals having discontinuities with high spikes. The wavelets can also model the music, speech, music, non-stationary stochastic signals and video. The wavelets may be used in applications such as human vision, turbulence, vibrational signal compression, earthquake prediction and radar etc.

The term "wavelets" is utilized to designate a set of basic functions of orthonormal produced by a mother wavelet ψ and translation of scaling function $\phi$and dilation. The scale of representation of multi-resolution discrete function can be called as a Discrete Wavelet Transform. Discrete Wavelet Transform is a quick linear operation on a vector of data, whose length is an integer power of 2. This conversion is orthogonal and invertible, where the inverse transform showed as a transpose matrix is the transform matrix. The basis of wavelets or function, different cosine and sines as in Fourier Transform, are well localized in space. However similar to cosines and sines functions, independent wavelets are localized in frequency.

The wavelet or orthonormal basis is characterized as

$$\psi_{(j,k)}(x) = 2^{j/2}\psi(2^j x - k)$$

The scaling function is specified as

$$\phi_{(j,k)}(x) = 2^{j/2}\phi(2^j x - k)$$

Where $\psi$the wavelet functions and j is integers that scale the wavelet function and k is integers that dilate the wavelet function. The wavelet equation, in terms of the wavelet coefficients is

$$\psi(x) = \sum_k^{N-1} g_k \sqrt{2\phi(2x-k)},$$
$$k = 0,1,2, \dots \dots \dots .. N-1$$

Where g_k is high pass wavelet coefficient.

The scaling equation is defined in terms of the scaling coefficients as

$$\phi = \sum_k^{N-1} h_k \sqrt{2\phi(2x-k)}$$

Where $\phi(x)$ is scaling function and h_k is low pass scaling coefficients. The scaling and wavelet coefficients are associated by the quadrature mirror relation, hence

$$g_n = (-1)^n h_{1-n+N}$$

Where N is the number of vanishing moments, the graphical illustration of Discrete Wavelet Transform is

The wavelets are categorized into a category by the number of moments of vanishing N. Within every category of wavelets there are sub-classes of wavelets separated by the level of iterations and by the number of coefficients

V. RESULT AND SIMULATION

5.1 GA BASED VIBRATIONAL SIGNAL ANALYSIS

5.1.1 Signal analysis View of GA Method:

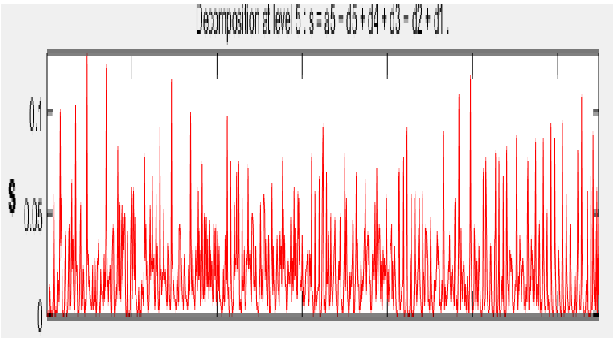

Fig.5.1 GA analyzed G+10 sandwich beam building Vibrational signal.

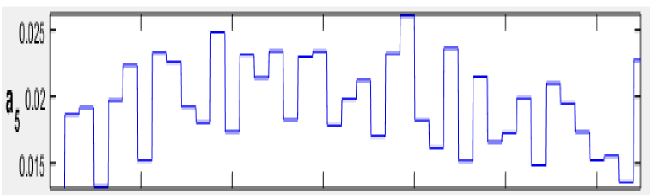

Fig.5.2 GA Complete Iteration Vibrational signal reconstruction sandwich beam.

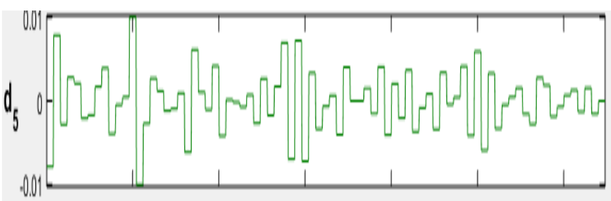

Fig.5.3 Denoised signal, Improved of signal strength using GA Complete Iteration Vibrational signal reconstruction and noise removal sandwich wall.

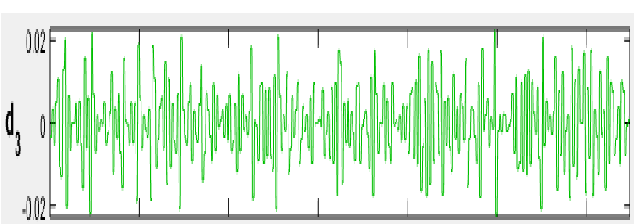

Fig.5.4 sandwich wall Noisy of vibrational signal.

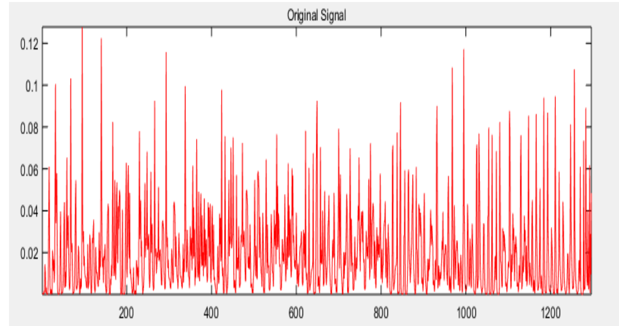

Fig.5.5 FFT with GA view of vibrational signal.

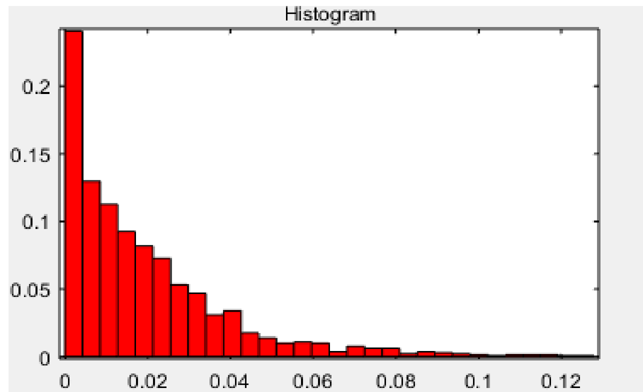

Fig.5.6 Performance histogram of vibrational signal using GA method.

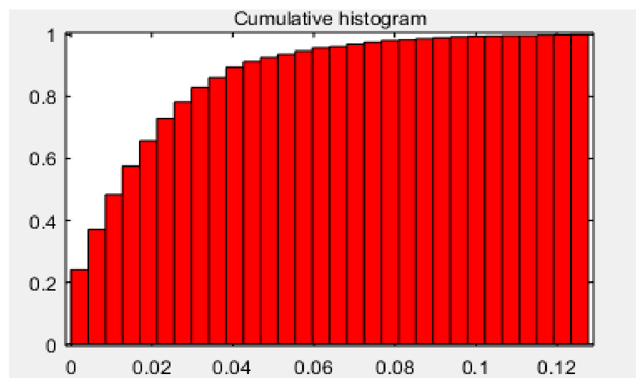

Fig.5.7 Error Cumulative histogram of vibrational signal using GA method,

5.1.2 SIGNAL ANALYSIS PARAMETERS OF GA METHOD

Table (5.1) Signal analysis parameters of GA Method.

S.n.	Parameters name	GA analysis Value
1	Noise mean	0.0193
2	Median value of noise	0.01346
3	Beam Identified signal Noise mean	0.00213
4	Beam Standard deviation	0.01997
5	Wall Standard deviation	0.01011
6	Wall Identified signal Absolute deviation Noise mean	0.01473

5.2 DISCRETE WAVELET TRANSFORM BASED VIBRATIONAL SIGNAL ANALYSIS

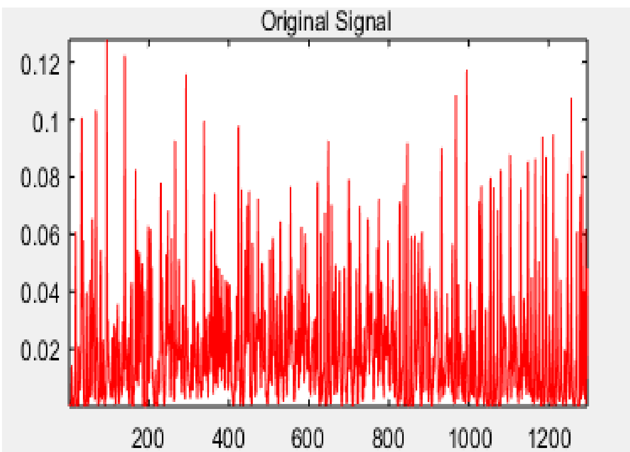

Fig.5.5 DWT analyzed G+10 building Vibrational signal sandwich beam.

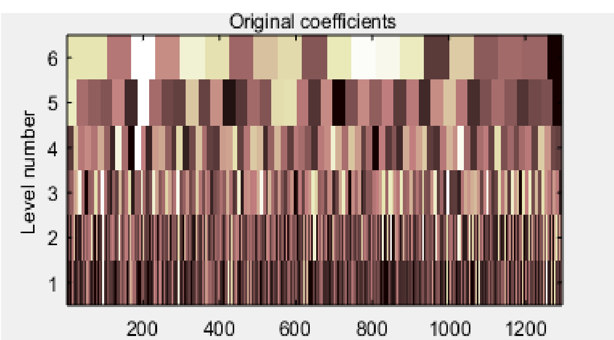

Fig.5.6 DWT coefficient of vibrational signal.

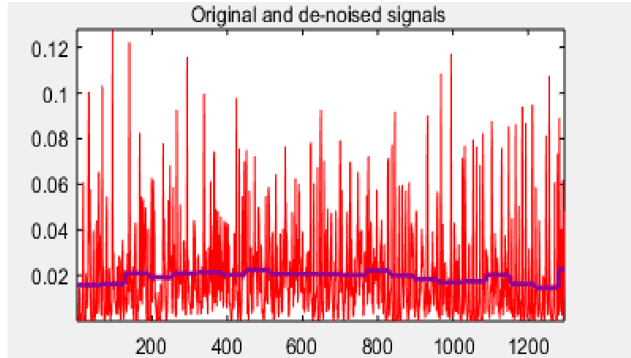

Fig.5.7 Signal thresholding and filtration of Original signal.

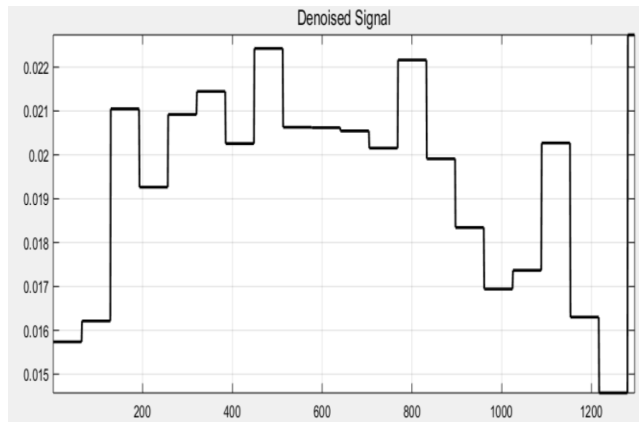

Fig.5.8 DWT Denoised signal and signal strength improvement sandwich beam.

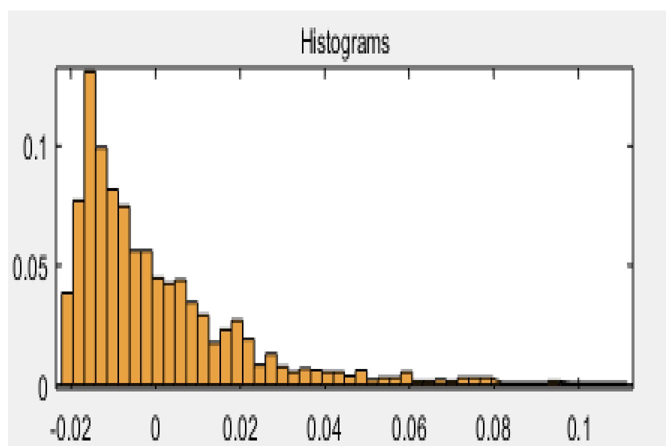

Fig.5.9 Performance histogram of vibrational signal using DWT method.

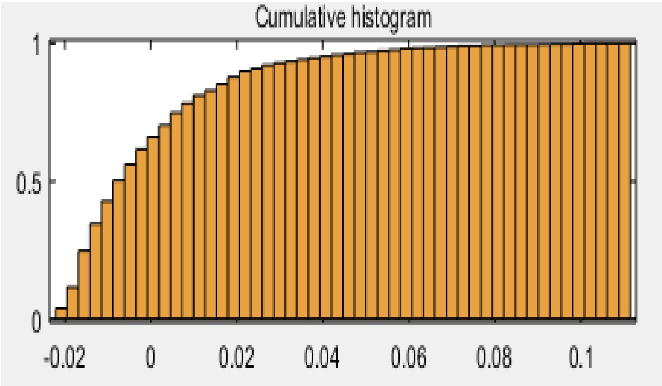

Fig.5.10 Error Cumulative histogram of vibrational signal using DWT method.

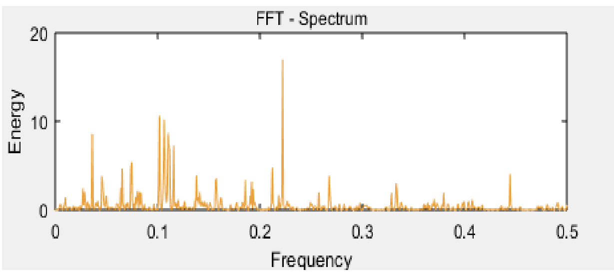

Fig.5.11 sandwich wall Noisy of vibrational signal.

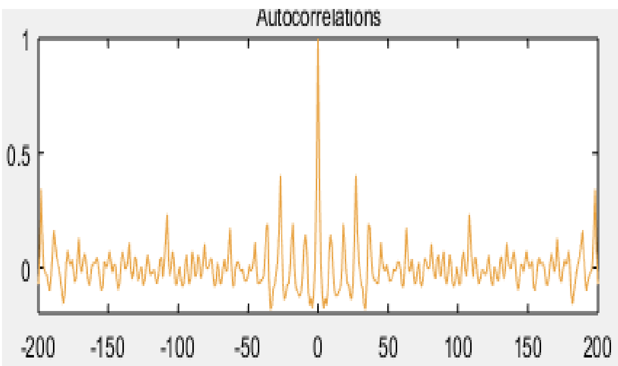

Fig.5.12 sandwich wall improved of vibrational signal.

5.2.2 SIGNAL ANALYSIS PARAMETERS OF DWT METHOD

Table (5.2) Signal analysis parameters of DWT Method.

S.n.	Parameters name	DWT analysis Value
1	Noise mean	0.1116
2	Median value of noise	-0.006194
3	Beam Identified signal Noise mean	-0.01548
4	Beam Standard deviation	0.01984
5	Wall Standard deviation	0.009163
6	Wall Identified signal Absolute deviation Noise mean	0.01455

5.3 COMPARISON BETWEEN BOTH METHODS:

Table (5.3) Comparison between both methods.

S.n.	Parameters name	GA analysis Value	DWT analysis Value
1	Noise mean	0.0193	0.1116
2	Median value of noise	0.01346	-0.006194
3	Beam Identified signal Noise mean	0.00213	-0.01548
4	Beam Standard deviation	0.01997	0.01984
5	Wall Standard deviation	0.01011	0.009163
6	Wall Identified signal Absolute deviation Noise mean	0.01473	0.01455

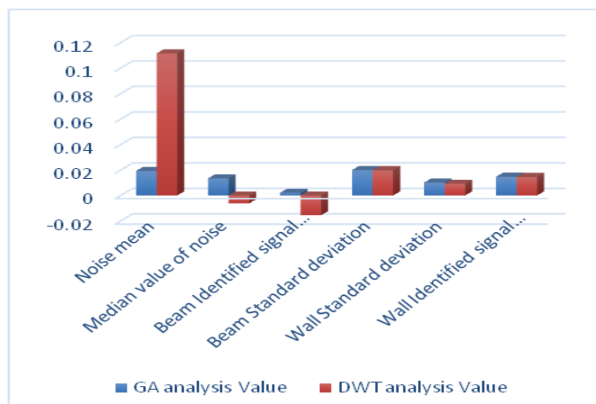

Fig.5.13 Comparison between both methods.

VI. CONCLUSIONS

In this research based identification of Sandwich beam vibrational signal using two different type of method. We have to perform of GA and DWT using MATLAB analysis software. Table 5.1 shows as GA result and table 5.2 is shows DWT results. Now comparison between each technique identify signal mean in DWT method is -0.01548 Lower then Genetic optimization method. With observed lower standard deviation of noise level 0.01984 as compare to GA value like as 0.01997 in a beam case and similarly to analyze of wall 0.01455 in DWT and 0.01473 in GA based result. Hence in this comparative study observed DWT is best analysis technique as compare to genetic algorithm.

The dominant frequency domain of the building became smaller and gradually concentrated to the low-frequency domain to the 2th floor. The response signal of the building to the blasting vibration was widely distributed in the frequency domain, but its main frequency band was basically between 0 and ∼140 Hz.

With the increase in the building floor, the high-frequency particle velocity gradually decreased, gathered to the low frequency, and developed from the dispersed multiband to the concentrated low-frequency band. This trend was evident in the *z*-direction. There were multiple peaks in the vibration velocity of each direction with the frequency band distribution, and the frequency domain corresponding to the peak was dispersed.

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