Experimental Vibration Response of Steel Structure Using FFT Analyzer With And Without Bearings

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Abstract- *Vibrations are time dependent displacements of a particle or a system of particles with respect to an equilibrium position. If these displacements are repetitive and their repetitions are executed at equal interval of time with respect to equilibrium position the resulting motion is said to be periodic. One of the most important parameters associated with engineering vibration is the natural frequency. Each structure has its own natural frequency for a series of different modes which control its dynamic behavior. Whenever the natural frequency of a mode of vibration of a structure coincides with the frequency of the external dynamic loading, this leads to excessive deflections and potential catastrophic failures. This is the phenomenon of resonance. An example of a structural failure under dynamic loading was the well-known Tacoma Narrows Bridge during wind induced vibration.*

I. INTRODUCTION

An FFT (Fast Fourier Transform) spectrum analyzer works in an entirely different way. The input signal is digitized at a high sampling rate, similar to a digitizing oscilloscope. The resulting digital time record is then mathematically transformed into a frequency spectrum using an algorithm known as the Fast Fourier Transform or FFT. The FFT is simply a clever set of operations which implements Fourier's basic theorem. The resulting spectrum shows the frequency components of the input signal. Now here's the interesting part. The original digital time record comes from discrete samples taken at the sampling rate. Fourier's basic theorem states that any waveform in the time domain can be represented by the weighted sum of pure sine waves of all frequencies. If the signal in the time domain (as viewed on an oscilloscope) is periodic, then its spectrum is probably dominated by a single frequency component. What the spectrum analyzer does is represent the time domain signal by its component frequencies.

The basic criteria while providing superior seismic resistance of a building is the difficulty in minimizing the interstate drift and floor accelerations simultaneously. Large inter story drifts cause damage to nonstructural components. These drifts can be minimized by stiffening the structure, but this leads to amplification of the ground motion, which leads to high floor acceleration, which can damage non-structural components. Making the system more flexible can reduce floor acceleration, but this leads to large inter story drifts. The only practical way of reducing inter storey drift and floor acceleration simultaneously is to use Base Isolation, which provides the necessary flexibility, with the displacements concentrated at the isolation level. In traditional approaches, in order to achieve capacity we should decrease demand as we cannot indefinitely increase the strength of the structure. As earth quakes cannot bepredicted or controlled, we modify demand by mitigating effects of the foundation to super structure. There are many possible ways to strengthen the system by introducing several devices in structural system. These include elastomeric bearings, sliders, rollers, sliding plates, rocking foundations etc.Of these elastomeric bearings and sliding foundations are most practical ones. Seismic isolation is intended to prevent earthquake damage to structures, buildings and building contents. One type of seismic isolation system employs load bearing pads, called Isolators. Since the isolators carry large vertical loads and deform to significant lateral displacement, the components of the structure above and below the isolator need to be designed properly. Specifically, to make isolation system work in proper manner, the structure should be free to move in any direction up to the maximum specified displacement. Base isolation is achieved by inventing several isolation devices to meet the desired requirements of an earthquake resistant structure.

II. STATE OF DEVELOPMENT

BEARINGS

G.Mounica, Dr. B.L.Agarwal Only fewer are being provided base isolation systems or devices. Base Isolators have been in large use since three decades and have been used mostly in bridges. These base isolators should be effective for members/ supports under compression and tension. Various advancements had taken place from the earlier periods till now to build earth quake resistant structures such as Mud layer below the structure, Sand layer, Roller and Rubber bearings as foundation support, Laminated rubber bearing system, New-

Zealand bearing system, Sliding resilient- friction system, Friction pendulum system, Sleeved pile isolation system, Viscous damping devices such as Visco- Elastic dampers (VEDs),Tuned Liquid dampers (TLDs),Shape Memory Alloy Dampers (SMADs) etc., Here we shall be studying earthquake resistivity of structure by analyzing the Base isolated structure to compare its structural performance with fixed base structure. We have analyzed a fixed building and Isolated building with EQ loading conditions using ETABS software and discuss all the possible advantages by using isolators in the structure which make the structure flexible and rigid simultaneously to achieve resistance against natural calamity such as earthquakes.[1]

Mkrtycheva, Dzhinchvelashvilia,Bunova "Study of Lead Rubber Bearings Operation with Varying Height Buildings at Earthquake "The paper studies the efficiency of seismic isolation system in the form of lead rubber at multi component seismic impact. As an example, seismically isolated monolithic ferro-concrete 5-, 9- and 16-storey buildings are considered. The solution of the problem is obtained by a direct integration of the motion equations for an explicit scheme in the software package LS-DYNA. The calculation is performed considering the nonlinear nature of lead rubber bearings.The analysis of the effectiveness of buildings with and without seismic isolation it is performed.[2]

Ms. Minal Ashok Somwanshi and Ms. ReenaPantawane The use of base isolation is the best method to reduce inter storey drift and floor accelerations. A new type of base- isolation system is developed here for a multi-storey reinforced concrete building. This work deals with modeling and analysis of 13 storey rigid jointed plane frame for two cases. First case is fixed base and second case is base isolated. Modeling and analysis is done using ETABS software for Bhuj earthquake ground motion records. Maximum vertical reaction is obtained from analysis in ETABS software. Using this vertical reaction and total mass of structure lead rubber bearings are designed manually. Time history analysis is carried out in order to evaluate floor response, accelerations and displacements during a ground motion. This paper intends to demonstrate how an isolation system can be efficient, evaluating its effectiveness for the building in terms of maximum shear force, maximum bending moment, base shear, storey drift and storey displacement reductions.[3]

Yogesh Narayan Sonawane, Mahesh NavnathPatil The concept of seismic isolation has become a practical reality with the development of multilayer elastomeric bearings. These bearings are very stiff in the vertical direction and can carry the vertical load of the building but are very flexible in horizontally, thereby enabling the building move laterally like a rigid mass under strong ground motion. The main purpose of this study is to check the behavior of the buildings in seismic zone by using base isolation concept, and reduce the story acceleration, story drift and increase the period of oscillation due to earthquake ground excitation, applied to the superstructure of the G+8 building by installing base isolators like lead rubber bearing (LRB) at the foundation level then compare the performance between the fixed base condition and base isolated condition by using SAP software.[4]

Tomohiro SASAKI &Eiji SATO Keri The building was tested under three different configurations: 1) base isolated with triple friction-pendulum bearings (TPB), 2) base isolated with a combination of lead-rubber bearings (LRB) and cross-linear bearings (CLB), and 3) fixed-base. This paper introduces the results of shake table experiments on full-scale base-isolated building and shows the effectiveness of recent base-isolation techniques for frequent, near-fault and long duration subduction earthquakes. Based on experimental results, it was found that TPB system provided greater attenuation of floor accelerations for the ground motions with PGA larger than 10 m/s2while LRB-CLB system provided greater attenuation of floor accelerations for ground motions with PGA smaller than 5 m/s2.Govardhana, , D.K. Paul Seismic base isolation is one of the most commonly implemented and established earthquake protection systems. Seismic base isolation is a technique that mitigates the effects of an earthquake by essentially isolating the structure and its contents from potentially severe ground motion, especially in the frequency range where the building is most affected.[5]

III. FFT ANALYZER

VikramTalekar,LSDhamande FFT analyzer can helps to detects in various components without disturbing setting of that component. Condition monitoring of bearings is important to avoid severe failures. Vibration analysis gets much advantage in factories as a predictive maintenance technique. In presented paper vibration response of non-defective bearing has taken and then purposefully various defects various component of bearings have made. It shows that every defect excites the system at its characteristic frequency. The location of the faults is indicated by the FFT Frequency domain spectrum. Also Signature analysis of bearing to observe unbalance, misalignment with increase in speed has done.[6]

Himanshu K. Patel, Dhagash Shah, AvaniRaghuwanshiThe most significant role of an industrial machine is its longevity i.e its ability to perform normally and to produce accurate results for extensively long periods of

time. To sustain that longevity of the machine, 'Health Monitoring' is required. Health Monitoring is a promoted and very helpful tool for predictive maintenance techniques. When a machine breaks down, the consequences can range from a personal injury to a public disaster. For this reason, early detection, identification, and rectification of machine faults are required to ensure the safe operation of the machine. When the faults begin to develop in a machine, some of the dynamic properties of the machine change, which influences the machine vibration level and spectral vibration properties. Such changes can act as an indicator for early detection and identification of developing faults. Vibrations are majorly found in the rotating shaft. The rotating shaft vibrates extensively due to improper alignments and imperfect bearings.[7]

Mohammad Vaziri, Ali Vaziri, Prof. S.S. Kadam A straight, horizontal cantilever beam under a vertical load will deform into a curve. When this force is removed, the beam will return to its original shape; however, its inertia will keep the beam in motion. Thus, the beam will vibrate at its characteristic frequencies. If a thin film is sputtered onto the beam, the flexural rigidity will be altered. This change causes the frequency of vibrations to shift. In this paper mathematical modeling of a cantilever beam with rectangular cross section in lateral vibration is investigated. This model could be of use in building a controller for reducing vibrations in the mentioned cantilever beam Analysis has been done in two categories which are called as Static and Dynamic analysis. Due to the analysis, displacement in the free end, critical points, stress concentricity, nodal solution, and shape functions are going to be shown. As mentioned the obtained modeling can be called as the first step of controlling the vibration by the piezoelectric elements.[8]

IV. VIBRATIONS

Gawali A.L., Sanjay Kumawat Dynamic structures subjected to periodic loads compose a very important part of industrial machineries. One of the major problems in these machineries is the fatigue and the cracks initiated by the fatigue. These cracks are the most important cause of accidents and failures in industrial machinery. In addition, existing of the cracks may cause vibration in the system. Thus an accurate and comprehensive investigation about vibration of cracked dynamic structures seems to be necessary. On the base of these investigations the cracks can be identified well in advance and appropriate measures can be taken to prevent more damage to the system due to the high vibration level. Typical situations where it is necessary to consider more precisely the response produced by dynamic loading are vibrations due to equipment or machinery, impact load produced by traffic, snatch loading of cranes, impulsive load produced by blasts, earthquakes or explosions. So it is very important to study the dynamic nature of structures.[9]

Hasan Ghasemzadeh1, Hamid RahmaniSamani and MasoudMirtaheri New approximate formulas are proposed to determine the natural frequencies of structures considering the effects of panel zone flexibility and soil-structure interaction. Several structures with various earthquake resisting systems are idealized as prismatic cantilever flexural-shear beams. Floor masses are considered as lumped masses at each story level and masses of columns are evenly distributed along the cantilever beam. Soil-structure interaction is considered as axial and rotational springs, whose potential energy are formulated and incorporated into overall potential energy of the structure. Subsequently, natural frequency equations are derived on the basis of energy conservation principle. The effect of axial forces on natural frequency is also considered in the proposed formulas. Using the method presented in this study, natural frequencies are computed using a simplified method with no complex numericalmodeling. The proposed formulas are verified via experimental and numerical methods. Close agreement between the results from these three approaches are observed. Furthermore, , the effects of panel zone flexibility, continuity plates and doubler plates on the natural frequencies of buildings are investigated.[11] Vishnu Kv, AnoopBk, Adarsh KsVibration Analysis: A Literature Review This paper covers the basic idea behind the vibration analysis and uses that information to reduce failures and thus save resources. This paper gives an idea on why vibration monitoring is important, How vibration is described? and, How to measure these vibration?.The extend of vibration analysis depends on the purpose of carrying out vibration analysis.[12]

Siddika, Md. RobiulAwall, Md. Abdullah Al Mamun and T. HumyraThis study based on free vibration analysis and study the behavior of framed structure under different frequency of vibration using ANSYS software and shaking table. A small scale uni-axial shaking table was prepared in laboratory, which can produce lower to moderate vibration, regarding frequency and velocity. Moment resisting framed structures constructed with connecting beam and column elements of mild steel wire of different dimensions were tested in shaking table and analyzed using ANSYS software. The effect of masses and stiffness of structures on its natural frequency and deflection under certain ground vibration also studied and discussed. The test results showed that, this shaking table is satisfying the general concept of free vibration. The height of structures has an inverse effect on its natural frequency for same lateral stiffness. After several shaking, structure's natural frequency started to decreases with

their decreasing stiffness. Therefore, the fabricated shaking table can used in free vibration analysis.[13]

Hsiung-Cheng Lin, Yu-Chen Ye, Bo-Jyun Huang and Jia-Lun SuIt is known that the vibration impulses occurred from a bearing defect are non-periodic but cyclostationary due to the slippage of rollers. The vibration status is often perceived to be synonymous with quality and thus used for predictive maintenance before breakdown. As a result, the analysis of vibration has been used as a key condition tool for fault detection, diagnosis, and prognosis. Any defect in a bearing causes some vibration that consists of certain frequencies depending on the nature and location of the defect. Although many techniques for time–frequency analysis are reported to measure vibration signals, they were found less efficient in practical applications. For this reason, this article develops an on-line bearing vibration detection and analysis using enhanced fast Fourier transform algorithm. The relation between major vibration frequency and dispersed leakage caused from fast Fourier transform can be induced, and it is then used to establish a mathematical model to find major frequencies of vibration signal. Also, the dispersed energy can be collected to retrieve its original gravitational acceleration. The proposed model is developed using a simple arithmetic operation based on fast Fourier transform so that it is feasible for more efficient calculation in impulse signal analysis.[14]

Álvaro Cunha and Elsa Caetano,This article presents the evolution of experimental modal analysis in the civil engineering field, from input-output to output-only modal identification techniques. Many case histories are included from the experiences of the authors at the Laboratory of Vibrations and Monitoring at the University of Porto.[15]

V. CONCLUSION

This paper focuses only on the literature review of previously published studies.The findings of this study shows that every defect excites the system at its characteristic frequency. The location of the faults is indicated by the FFT Frequency domain spectrum. Also Signature analysis of bearing to observe unbalance, misalignment with increase in speed has done. This paper intends to demonstrate how an isolation system can be efficient, evaluating its effectiveness for the building in terms of vibrations, specifically natural frequency. Typical situations where it is necessary to consider more precisely the response produced by dynamic loading are vibrations due to equipment or machinery, impact load produced by traffic, snatch loading of cranes, impulsive load produced by blasts, earthquakes or explosions. So it is very important to study the dynamic nature of structures.

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