Differential Effects of Support Conditions on Dynamic Parameters

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1. INTRODUCTION

Many engineering structures when exposed to various external loads such as earthquakes, traffic, explosion and vibration during their lifetime suffer damage and deterioration. This seriously affects their performance and may even lead to catastrophic structural failures. Health monitoring of engineering structures using dynamic testing has gained a lot of interest over the last few years. The basic idea behind this approach is that modal parameters namely natural frequency, mode shape, modal damping, are functions of physical properties of structures such as mass, damping and stiffness as well as boundary conditions. Therefore, any change in the physical properties or boundary conditions will in effect cause detectable changes in the modal parameters.Several studies, including those of (Scott et. al.1997, Young- Shin and Myung-Jee 2000, Johan 2003, A. Choubey *et. al.* 2006, Ricardo *et. al.* 2008, and Dantiele *et. al.* 2008), investigated the use of natural frequency or mode shape as a means of damage identification These studies were concerned with issues related to use of these modal parameters in determining the magnitude and localization of damage based on the relationship between dynamic and physical properties. One of the major concerns in the long term performance of bridges is the deterioration of boundary conditions as a result of stiffness change in bridge bearing pads over time. As such, the monitoring of the boundary conditions is very important in ensuring timely maintenance before any serious damage occurs to the structure. There have been some studies done on the effect of boundary conditions on the dynamic properties of the structure. Investigation to the effect of stiffness of the rubber pads on dynamic characteristics of base isolated bridge done by (W. Dai *et. al.* 2006). The results show direct relationship between rubber stiffness and frequencies. It shows whenever the rubber stiffness increases, frequencies increase as well. Investigation to the effect of support stiffness and damping on measured modal frequencies and damping ratios was done by (Thomas et. al. 2007). The effect of support system on both modal frequencies and modal damping were illustrated on two different types of structures. The effect of support condition on measurement of modal parameters was investigated by (Wolf 1984 and Carne 1998)They found that there is direct relationship between the support stiffness and the measured modal parameters. Many previous studies have used elastic bearing isolation systems to reduce seismic demand on structures, and many books have been written related to

the design of these systems (Skinner et. al. 1993, and Naeim and Kelly 1999). Various types of elastic bearings have been introduced as isolation systems. number of studies have investigated the effectiveness of different types of elastic bearings, their material properties and their behaviour under different loading and environmental conditions with respect to the seismic responses of bridges (Turkington et. al. 1989, Chaudhary1999, Chaudhary et. al. 2000,Chaudhary et. al. 2001, Jangid 2002, Boroschek et. al. 2003, and Daza et. al. 2004).

The main objective of this study is to investigate the effect of the differential different in support stiffness on both sides on the dynamic properties of a structure. Correspondingly the sensitivity of each fundamental bending frequency to changes and different support conditions will help to identify and establish the appropriate damage indicator. This is achieved by obtaining the reduction in natural frequency and by comparing mode shapes using the Modal Assurance Criteria (MAC).

2. DAMAGE INDICATORS

Modal parameters are used as damage indicators or dynamic properties monitoring tool. The change in natural frequency and mode shape are used as indicators to compare the results for different support conditions.