Seismic resistance of a structure using Gyroscopic Amplitude Absorber mechanism

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Abstract : This paper deals with the investigation and analysis of seismic resistance system utilizing gyro and its effectiveness in the control of the motion subjected to a seismic ground motion acceleration were studied. A gyro design was introduced as a seismic frequency absorber, which has potential for application to high-rise structures, towers and other structures. The non-linear motion of the gyro-column-beam system was studied. On other hand, the effect of the angular momentum of the gyroscope is studied and it shown that the behavior of the dynamic motion. The experimental results provides the workability of gyroscopic amplitude absorber mechanism.

Index Terms - Gyroscope,Wind vibration,Earthquake Action,Structural Control.

I. INTRODUCTION

Tallest structure is a kind of slender structure with larger height and smaller cross section, and the transverse load plays a major part in dynamic action. Because the beautiful shape, the Tallest structure is widely used in telecommunications, electricity industry, etc . Compared with ordinary structure, the horizontal stiffness of Tallest structure is small. It is sensitive to wind load and earthquake action and it is easy to trigger large static and dynamic response. As a result, the dynamic behavior and dynamic control of the high-rise structure get more and more attention .The devices which apply to dynamic control of high-rise structure include: viscous dampers, tuned mass damper, tuned liquid damper and tuned spring damper, etc. The mechanism of damping device is explicit. With optimized analysis, normal production and installation, effective damping can be obtained by using the device. The vibration of high-rise structure takes the first vibration mode as the principal thing, the optimal control location is usually at the top, but the location is partial soft and internal space is limited, which lead to the more requirements of quality and volume and the condition of the tuned damper in the practical application. Aiming at these problems, the research and development of the new type of the damping device are necessary, which effectively reduce the dynamic response of high-rise structure by other means.

Gyroscope is a kind of device which is based on the conservation of angular momentum theory and designed to sense and maintain direction. Gyroscope is mainly composed of gyro rotor, frame and accessories, when the axis of the gyro rotor rotates at high speed, will produce inertia and resistance, pointing in the direction of fixed the gyro rotor axis of rotation, the nature is called fixed axis. Zheng-Hao Wang once used single -degree-of-freedom gyro method for structure stochastic control based on conservation of gyro axis , but this method is brief and can't realize multidirectional vibration reduction.

This paper which based on this theory advances a kind of gyroscopic amplitude absorber, and it can control horizontal vibration of the structure. Subject to wind load and earthquake action, the inner rotor of the damper can rotate with high speed, fixed axis gyro can provide reverse torque which reduces the horizontal deformation of the structure, and the overall damper has the function of dissipating external kinetic energy so as to ensure the safety of structure.

This paper exlplores mechanics principle of the gyroscopic amplitude absorber with two degrees of freedom gyro, and the damping effect on Tallest structure of the gyroscopic amplitude absorber is studied. Results show that the reasonable arrangement of gimbal gyroscope damper can effectively control the horizontal and torsional vibration of the structure which subject to wind load and earthquake action.

II. METHODOLOGY

The three storey single bay structure was used to test the vibration control as an experimental level. The model structure was made up of wood and plywoods. The building model was placed above the schierle shake table. The gyroscopic amplitude absorber was placed on above the building model structure. This setup will helps to experiment and knowledge the efficiency of the gyroscope.

III. EXPERIMENTAL INVESTIGATIONS

The experiment involves that to identify the workability of gyroscopic amplitude absorber which is placed on the wooden three storey single bay structure. The rotor plate rotates with 11000-12000rpm with the weight of 0.85Kgs. The following results are there which is to be finalising the performance of the gyroscopic amplitude absorber.

The experiment was stepped out as following procedure. The frequency of the model building structure using oscilloscope which was generated by shake table was noted without gyroscopic amplitude absorber and then another frequency of model building structure was noted with gyroscopic amplitude absorber. As finally from this comparison the result was established.

IV. RESULTS AND DISCUSSION

4.1 Results of Descriptive Statics of Study Variables

Table 4.1: The results without Gyroscopic amplitude absorber

Storeys / displacement	From pushing side(Cm)	From pulling side(Cm)
First storey	-1.5	1.5
Second storey	-2	2
Third storey	-3	3

Table 4.1 displayed mean, the displacement of the structure studied from experiment with stands to make mode shape of the structure.

Table 4.2: The results with Gyroscopic amplitude absorber

Storeys / displacement	From pushing side(Cm)	From pulling side(Cm)
First storey	-0.2	0.2
Second storey	-0.75	0.75
Third storey	-1.25	1.25

Table 4.1 displayed mean, the displacement of the structure studied from experiment with stands to make mode shape of the structure.

Fig 1 The model structure with gyroscopic amplitude absorber under shake table

IV. CONCLUSION

The results from this experiment shows that gyroscopic amplitude absorber effectiveness. This experiment proves that the gyroscopic amplitude absorber can be used in tallest structure in future to resist the earthquake action and wind vibration. And also it is the advanced damper with good efficiency as per results we knowledge that.

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