ACQUISITION DATA MANAGEMENT FROM VIBRATION OF A TALL RECTANGULAR BUILDING

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Abstract

The present paper describes the acquisition data management from vibration of a tall rectangular building model in wind tunnel. It may help the beginners working at the wind tunnel. For the same purpose, a tall rectangular model, having prototype dimensions 300 meters height, 50 meters length and 25 meters width. It is the author experience which is articled here. We can simultaneously measure the accelerations, displacements, velocities, forces and etc, in alongwind as well as acrosswind directions in both orientations, i.e., long afterbody and short afterbody.

1.INTRODUCTION

It is obvious that in wind tunnel testing of buildings model, every one measures the displacements and accelerations at a reference height. Since the data acquisition systems measure the output voltages only, therefore, it is necessary that the aforesaid parameters should be calibrated by output voltages. After getting of data from the data acquisition systems in time history format, the management of their, is very important. In the present paper, the author gives his hitch hikers guide to the beginners working at wind tunnel which never has been mentioned in past research works. For this purpose, an aeroelastic model of a tall rectangular building with proportions of 12:2:1 having 300 meters height were installed in working section of a wind tunnel. Dimensions of the tunnel section were 2.1m*2.0m. The output voltages in the personal computer calibrated with tip displacements and accelerations of the building model. For tip displacements calibrations, as it can observe from figure 1, it was necessary that tip displacement produce by hanging of weights through a pulley at the tip level of the model. The output voltages can be calibrated with respect to forces by multiplying the weights with gravity acceleration which I have never seen it in the literature. By having the time history of the tip displacements and forces, one can be measure the base shear force and distribute it at the height of the building as the distribution of the earthquake effects.

2. EXPERIMENTAL SETUP

The experimental setup includes:

1. Generation of different flow conditions.
2. Study of response of isolated model in different flow conditions.
3. Study of interference effect due to vicinity of other buildings

Velocity profiles corresponding to α=0.12, 0.18, 0.24, and 0.30 for the four standard categories of terrain, have been generated. The Velocity profiles obey from the expression:

$$(V_z / V_0)=(Z / Z_0)^{\alpha} \qquad (1)$$

A sample of velocity as well as wind turbulence profile has shown at Fig 2 & 3. As it is seen from Figures, a good agreement exists between experimental and theoretical mean wind velocity profiles.

3. STUDY OF RESPONSE OF AEROELASTIC MODEL IN ISOLATED CASE

In the isolated case, the responses of the aeroelastic model, i.e., displacements and accelerations at the top of the building model, have been studied in the two principal directions for four flow conditions. The study has been carried out in both long and short afterbody orientations. After recording of the raw data, the statistical characteristics of the responses have been calculated as explained below.

1. Mean, RMS, positive peak factor (ppf), negative peak factor (npf), maximum & minimum alongwind and acrosswind displacements and base shear forces. For acrosswind displacements and shear forces, there is not mean values.
2. RMS, positive peak factor (ppf), negative peak factor (npf), maximum & minimum alongwind accelerations
3. The results for all wind flows have been used to study the effect of turbulence characteristics while the results for forth boundary layer flow has been used to compare with the results of the interference case to obtain the ' buffeting factors'.

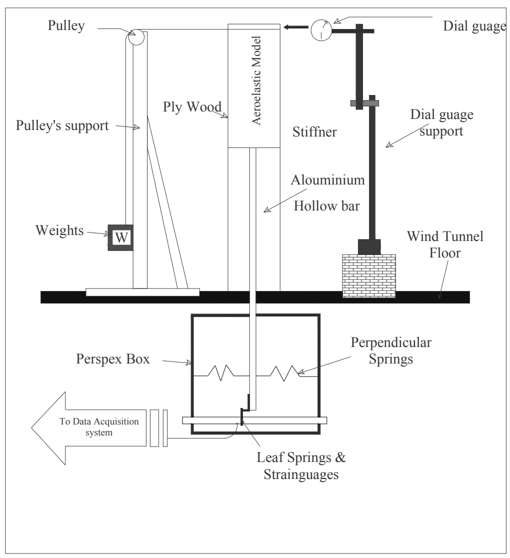

FIG 1- SCHEMATIC OF AEROELASTIC MODEL AND CALIBRATION SETUP

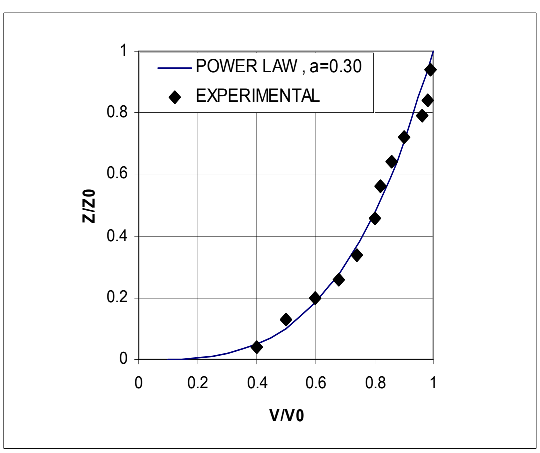

Fig. 1. Mean Wind Velocity Profile

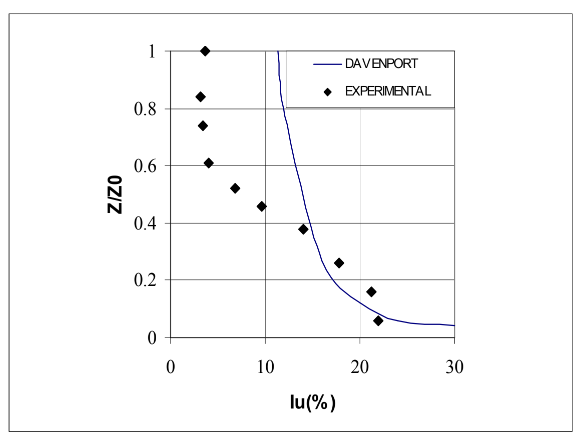

Fig. 2. Turbulence Intensity Profile

4. INTERFERENCE EFFECTS STUDY

The interference effects have been studied in two parts. Part one pertains to study of interference effect due to a single interfering building located upstream or downstream of the principal building. Part two pertains to the study of interference effect due to two interfering buildings one located upstream and the other downstream of the principal building.

The following cases have been covered:

1. Principal building model and interfering building model, both in long afterbody orientation.
2. Principal building model in short afterbody orientation and interfering building model in long afterbody orientation.
3. Principal building model and interfering building model, both in short afterbody orientation.

In all the above mentioned studies, the strain gauge and accelerometer signals were acquired through the data acquisition system. In each record a minimum of 4000 samples of a signal were recorded. **Lock-in phenomenon has observed in isolated as well as interference case.**

5. OTHER USES OF ACQUISITED DATA

The other forms of data, one can directly obtain base shear forces of the building in all cases studies which have mentioned above. Generally, the buffeting factors for wind interference study define for the accelerations and displacements, therefore, such factors can be define for velocities and non-dimensional acrosswind as well as alongwind orientations spectra in isolated case and wind interference case. The benefit of the such buffeting factor is more usefuler than the other cases. Such a research study has already been reported by the author in his past papers. The reason for the aforesaid article is that for the generation of the buffeting factors, measurement of the displacements and accelerations are necessary, separately. In the case of last one, measurement of displacements is enough. Because, kareem has given a relation for the calculation of the accelerations, displacements, velocities and jerks from the non-dimensional force spectra as below:

$$\sigma_y^2(r) = \sum_{n=1}^{N} \frac{\pi n S_f(n).(2\pi n)^{2r}}{4(2\pi n)^4 \xi_n m_n^2} \qquad (2)$$

in which ξ_n is the damping ratio in the n^{th} mode, $S_f(n)$ and m_n the generalized power spectrum of the forcing function and mass in the n^{th} mode respectively [Kareem, April 1981]. Also **r** represents the response derivative , i.e , r = 0 for displacement, r =1 for velocity, r = 2 for acceleration, and r = 3 for jerk. A sample of the non-dimensional force spectra generated for interference case has shown in fig. 3.

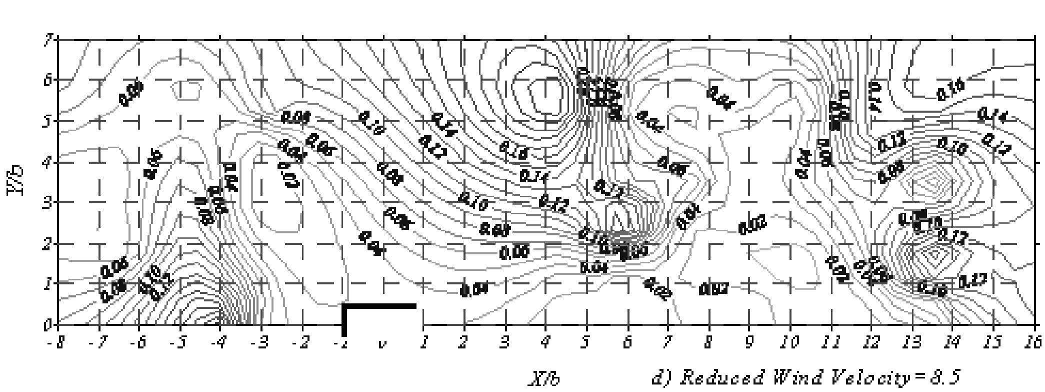

Fig 3. Non-Dimensional Acrosswind Force Spectra for wind interference case

Also every body can use form raw data for type of the probabilistic response study of the tall buildings, whether it is stationary, ergodic stationary, non-stationary, stochastic, periodic (in lock-in case) and etc.

6. CONCLUSIONS:

Some useful results of the present study are as below:

- The lock-in phenomenon has obsevrd for the building model studied.
- The acrosswind response dominating to alongwind response.
- From acqusisited data, every one can directly calculate base shear force due to wind effect and distribute it in the height of the building.
- From raw data, it can be estimated type of the response study.
- By generating of the non-dimensional acrosswind and alongwind force spectra for isolated as well as wind interference case, it can be obtain the displacements, velocities, accelerations, jerks, base shear forces and etc, which is so cheaper than the other cases.

7. SELECTIVE REFERENCES:

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