International Journal of Modern Developments in Engineering and Science
Volume 2, Issue 8, August 2023
https://www.ijmdes.com | ISSN (Online): 2583-3138

Modelling and Analysis of Stockbridge Damper for Transmission Line

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***Abstract*: The purpose of this work is to suggest a general scheme for Stockbridge dampers, which is subjected to specific design constraints. Stockbridge dampers are widely used to control the vibration frequency range and reduce vibration amplitude on electric lines due to wind, avoiding the risk of fatigue on the line. Acceptable performance of Stockbridge dampers must be maintained for a wide range of excitation frequencies, which have a correspondence with the wind velocity. In this thesis a simple approach for finding geometrical parameters, which are affecting the vibration frequency is proposed.**

***Keywords*: Stockbridge damper, transmission line.**

1. Introduction

A wide range of cables used in various engineering disciplines. The most amazing property of a cable is its ability to withstand large axial tension. That is the reason, why they are being widely utilized for the construction of overhead transmission lines, suspension-cable, cable-stayed bridges, stadium roof and other structures, where bearing of large tension is prerequisite.

Transmission lines are designed in worst weather conditions (solar heating, maximum external temperature, and wind speed) to control the maximum sag. In transmission lines, different types of vibrations may occur; the most common type corresponds to wind-excited vibrations, caused by vortex shedding. Vortex shedding is associated with the flow of air across a bluff body. Transmission lines are continuously subjected to wind forces that shorten the service life by cyclic conductor motions (Hagedorn P. et al., 2002). These wind forces generate three major modes of vibration which are Gallop, Aeolian and Wake-induced oscillations. Among them, Aeolian vibration, which is the most destructive one, which gives harmful results in the form of abrasion or fatigue failures over a period of time (Kermani M. et al., 2010). In order to overcome these crucial damages of Aeolian vibrations, various dampers are designed to minimizing vibrations and dissipates energy though the dampers. Stockbridge damper is the most common vibration damper used for Aeolian vibration. (Pinto Thiago D. F. et al., 2009).

2. Method

A. Methodology and Expected Outcome

Present work is geometrical modeling and analysis of Stockbridge damper using modeling and analysis software respectively. This software approach improves the overall performance of the system in certain operating conditions. Generation of CAD Model of a Stockbridge damper using wire rope of appropriate length and geometry. Vibration analysis of damper using the CAD Model, taking into account the contacts between individual wires to obtain required frequency range and dissipates vibration energy through Stockbridge damper.

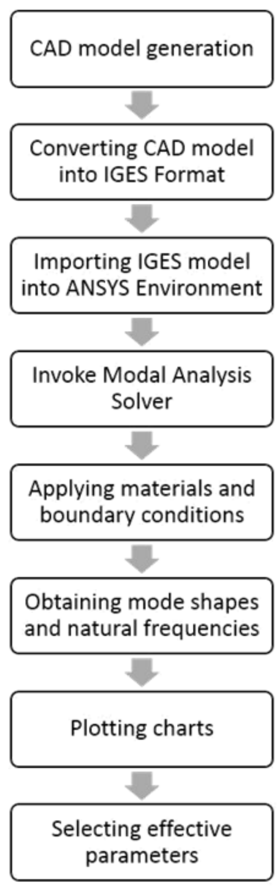

Fig. 1.

Finding number of vibrating mode shape, each mode shape

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may show maximum amplitude of vibration in the direction of mode shape. Basically, six or more number of mode shapes may help in study of nature of vibration in the Stockbridge damper. Plotting the results of mode shapes, natural frequencies and amplitude obtained in each mode. On the basis of collected data from modal analysis, establishing correlation among geometrical parameters of Stockbridge damper and natural frequencies.

By this study, performance of the Stockbridge dampers may be compared for any parameter and operating conditions such as conductor type, diameter of the messenger cable, mass and length of the messenger cable.

3. Result

A. Creating Simulation for Main Effective Parameters

Now taking dimensions of rope length in size increment with 50% and dimensions of mass size in size increment with 50%. The both 50% increments in one geometrical model of Stockbridge damper. The geometrical models are creating in CREO 2.0 and export into IGES file format and then send to ANSYS 14.0 for modal analysis. The updated geometric model with main effective parameters is shown in figure 2.

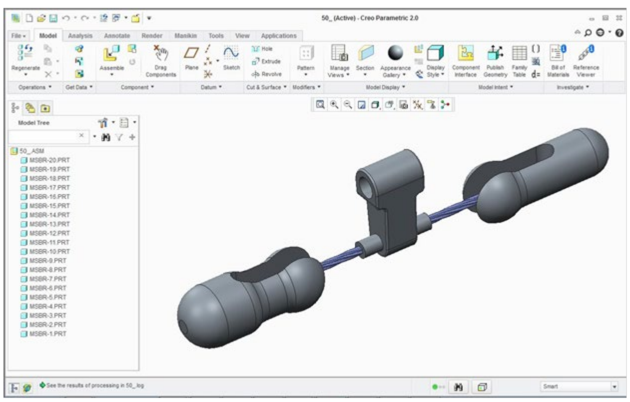

Fig. 2. Updated geometric model with main effective parameters

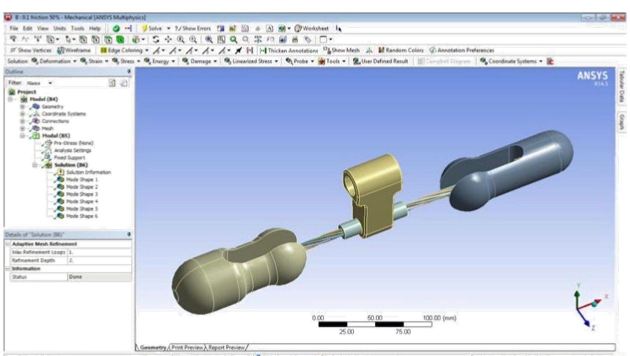

Fig. 3. Updated geometric model with main effective parameters in analysis environment

B. Preprocessing for Simulation Work

As per Material Properties. Selecting aluminum alloy material for clamp, structural steel for messenger cable, toughness of the material helps in control the vibration frequency of the damper. For both the weights cast iron material is used.

Defining contacts between the imported geometry assembled parts. The surface-to-surface contact type was defined between surfaces of the individual adjacent wires of the messenger cable considering frictional behavior mode with friction coefficient 0.1.

CONTA174 is an 8-node element that is intended for general rigid-flexible and flexible-flexible contact analysis. In a general contact analysis, the area of contact between two (or more) bodies is generally not known in advance. CONTA174 is applicable to 3-D geometries. It may be applied for contact between solid bodies or shells.

Surface-to-surface contact interactions describe contacts between wires in the individual layers and between wire layers caused by the masses load acting on the strand. This approach gives more accurate results but is time-consuming.

Bonded contact condition is defined between messenger cable and all remaining parts

Meshing Characteristics:

Solid element type	= SOLID186 - 3-D 20-Node
Contact elements	= CONTA174, TARGE170
Over all model mesh size	= 1.5 mm
Messenger cable mesh size	= 0.8 mm
Number of total nodes	= 97222
Number of contact elements	= 43060
Number of spring elements	= 0
Number of solid elements	= 30361
Number of total elements	= 73421

C. Boundary Conditions

Defining boundary conditions on Stockbridge damper model in the modal environment. Fixed constrained is given on the clamp at conductor hole circumference and both weights are free to vibrate. To obtained mode shapes, Total Deformation is add in the solution as post processing process. For each mode shape a new total deformation is needed in the solution. In the last solve the problem by clicking solve button by right clicking on solution cell in tree outline.

D. Simulation Results

Obtaining the results from the solving process of analysis in the modal analysis environment and displaying the results.

4. Conclusion

The proposed modelling and simulation procedure permits to select the objective function of greatest interest for the designer of Stockbridge dampers. From the analysis previously presented in this thesis, the following conclusions may be noted:

1. Vibration frequency is mainly influenced by mass of the damper weights, according to a continuously growing relation. However, the rate of growing of frequency decreases as the mass increases. This situation suggests the establishment of an interval for the mass to maintain this variable into practical values.
2. The length of messenger cable is the second most important variable influencing frequency. Up to

certain limit, the shortest value of the length produced the highest frequency.

3. The finite element method is an efficient tool in the optimization of dampers and in the analysis of influence of variables, making it possible to explore parameter within the design area.
4. The obtained frequency range is within the limits in the required frequency range 5 Hz to 50 Hz to absorb the vibration energy of conductor. Messenger cable length and mass size are the more suitable parameter for controlling the vibration frequency.
5. The optimum frequency comes out to be 88.26Hz for the overall assembly.
6. The Frequency of ACSR conductor comes out to be 575.48Hz, use of Stockbridge with the conductor results in less frequency hence Aeolian Vibration reduces with Dampers.

References

[1] Francesco Foti et al., "Hysteretic Behaviour of Stockbridge Dampers: Modelling and Parameter Identification," in Mathematical Problems in Engineering, 2018.