VIBRATION DAMPERS ON AAC AND AAAC CONDUCTORS

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ABSTRACT

The subject addressed is that Electricity Distribution companies often classify, for overhead lines, STOCKBRIDGE vibration dampers are for Transmission and plastic HELICAL vibration dampers are for Distribution.

The problem is that, whilst distribution companies generally use smaller conductors than in transmission, the above statement is not true for all types of conductors. Because of the author's involvement in the new IEC standards 62567 (Self damping of conductors) and IEC 62568 (Fatigue testing of conductors), further research has shown that in the absorption characteristics of aeolian vibration, the conductor self-damping plays an important role in the deployment of plastic helical or spiral vibration dampers. The AAC (All Aluminium Conductor) and AAAC (All Aluminium Alloy Conductor) have less self-damping than other conductors. [1]

So for these types of conductors, AAC and AAAC, a STOCKBRIDGE or coulomb absorbing type vibration damper is better suited for energy absorption.

Whilst the conductor diameter is never the governing factor in determining the size of vibration damper to be used, it is rather, the characteristic impedance of the conductor and the manufacturer's known characteristics of their dampers to match. [2] So the lower CI values, less than say 50 N/m, the Helical Vibration Damper (HVD) may be better suited.

$Zm = (T.W/g)^{0.5}$

The outcome of this paper is to provide a better vibration damping solution for electricity distribution companies' overhead lines and prevent catastrophic failure and fires.

FIELD RECORDINGS

A technical report dated 10 February 2010 was prepared as a result of the tests performed, following breakages of a 22 kV line. This line uses 19/3.25 AAC Neptune conductor and it has experienced a large number of conductor breakages caused by fatigue of the conductor strands. Aeolian Vibration is the primary cause of these failures as detailed in the report. These tests were performed on the original form of construction which uses no armour rods and no form of damping.

On 31st March 2011 a new set of tests was commenced at the same locations following re-conductoring of the line. At this stage, armour rods and helical vibration dampers had been fitted to the new conductor. Vibration recordings were obtained and the results shown in this report indicate that a significant improvement over the previous results was evident. It was suggested that helical dampers are not appropriate for this size of conductor and that better results could be obtained by using an improved form of Stockbridge damper. While helical dampers are excellent for very small conductors they are not suitable for larger conductors.

It was suggested by the authority that a further set of tests could be performed using Stockbridge dampers.
We now have three sets of data for this location.

Figure 1. Photo of the section of the line being measured for vibration.

Figure 2. View of recorder installed on vertical insulator on concrete Pole 314

Figure 3. View of line construction and recorder installation on the centre phase with armour rods and 4D dampers fitted to that phase.

Mass per unit length is 0.433kg/m Calculated Breaking Load (CBL) of Neptune AAC conductor is 24.7kN

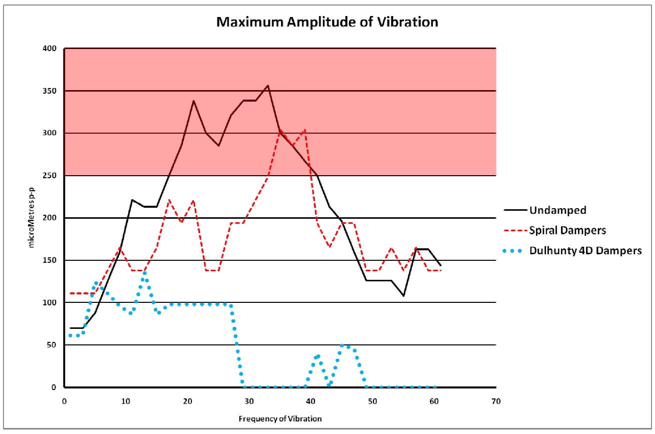
It is estimated that the conductor tension could be up to7 kN at the minimum temperature at this location (-2 °C). This corresponds to 28% of conductor breaking load and at this tension Aeolian Vibration can be a serious problem unless measures are taken to counteract it. The characteristic impedance is 127

Span length for the majority of the line section (including the section being tested) is 125 Metres. Maximum span length is 137 Metres.

RECORDING RESULTS

The measurements were made of reverse bending amplitude. Calculations showed that an "R Factor" of 1.3 applied to the measurements obtained and this was incorporated in the results.

The results are shown in the charts below. These are presented for the measurements made on the concrete poles. The same pattern was observed for the recordings on the wood pole but the amplitudes were not quite as severe.



An examination of the graphs of "Maximum Amplitude of Vibration" will show that the fitting of helical dampers and armour rods made a significant improvement in the vibration stresses on the conductor for frequencies below and up to around 30 Hz. However, for frequencies above this, there was little or no improvement and the conductor still experienced vibration stresses which exceeded permissible limits.

The 4D damper tests experienced the coldest conditions of the three so they were tested under the most arduous conditions of the three. Clearly, for this application, 4D dampers showed a much better performance than helical dampers.

Subsequent investigation and testing has revealed that better solutions are available as demonstrated.

DISCUSSION

Sunkle [4] and others [5], [6] have shown that a helical vibration damper works by;

a) Reflecting energy back into a span with different wavelengths, amplitudes and frequencies.
b) Absorb energy by noises when the helical damper impacts to the conductor.

However the majority of this energy as shown by [5] is the reflected type which is only absorbed by the conductor's self-damping

Rawlins [1], [7] has shown that self-damping is directly proportional to Young's modulus E and the higher the modulus, the better is the self-damping.

The self-damping characteristics of a conductor vary with the conductor material, diameter, stranding, lay, vibration frequency and installation tension [8], [9],

Papailiou [10] advises that in relation to Bending Stiffness, the conductor follows with good approximation during bending, the bending equation;

M=E.J where EJ stands for the bending stiffness of the conductor. Final modulus of elasticity with constant values of Ea (56GPa) and Es (190GPa) [11], [12], [13]

Type	Strands	Al ratio	Steel ratio	Elasticity modulus in GPa
ADSS				15.3
Al	7	1		59
Al	19	1		56
Al	37	1		56
Al	61	1		54
ACSR	6/1	0.857	0.143	74.3
	30/7	0.811	0.189	80.5
	54/7	0.885	0.115	70.5
	54/19	0.888	0.112	70.2
Copper				117
Steel			1	190-210

Brennan [14], [15] relates fretting fatigue with tensile strength. Hence aluminium alloy wires have a greater fatigue strength than say aluminium (i.e. 6201A>1120>1350)

THE EFFECT OF DIAMETER

F= 0.185 v / d

Sunkle [4] and Mackness [16], [17] show that helical dampers are only effective at higher frequencies. A stockbridge damper is most effective at frequencies 0Hz to 80Hz. So ensuring laminar wind speeds 0 to 8m/s depending on terrain and obstacles, a diameter of less than, 9.25mm at 4 m/sec, or 4.625mm at 2m/sec is required to push the frequency response well above 80 Hz

CONCLUSION

1) SVDs are suitable for ACSR, Steel, Copper and trapezoidal wire diameters up to 14.3mm
2) For conditions of flat terrain or near bodies of water, SVDs are suitable for AAC and AAAC diameter less than 9.25mm.
3) For conditions of undulating, hilly or built up areas, SVDs are suitable for AAC and AAAC diameter less than 4.625mm

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