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Pictures taken at the test line with the test witnesses (December 19th, 2012): Keshab Mukherjee, Supreme & Co. Pvt. Ltd., test witness, Pierre Van Dyke, test engineer, Hydro-Québec, Alok Kr. Pal, Supreme & Co. Pvt. Ltd., test witness (From left to right).

Picture taken on January 8th, 2013: Mr. Keshab Mukherjee, Supreme & Co. Pvt. Ltd., test witness.

SPACER DAMPER

Introduction

Transmission of Electrical Power in bulk for a long distance is done through overhead lines where the power flows through Conductors which are supported by Insulators from Towers. The Conductors are always of stranded type and as the quantum of power goes up, instead of single conductor, bundle conductors are adopted in the same phase viz., twin, triple, quad, hexagonal, octagonal etc. Whenever multi-bundle conductors are used, in order to avoid clashing between sub-conductors and thereby resulting in damage of conductor, Spacer Dampers are deployed to maintain sub-conductor spacing throughout the run of line as well as to control vibrations on conductors.

Conductors are exposed to wind and act as a taut string thereby are subjected to different types of vibration/ oscillatory movements. Mainly following types of vibrations/oscillations may occur depending on surrounding conditions:

1)Aeolian Vibration:

This occurs under laminar flow of wind due to vortex shedding from the leeward side of the conductor and is the most common type of vibration. This high frequency low amplitude vibration generates bending strain at conductor clamping points owing to cyclic movement and give rise to fatigue failure of conductor. In case of bundle conductors, Spacer Dampers are deployed to limit such vibrations and bending strain within safe limits.

2)Sub-Span Oscillation:

Out of four classes of wake-induced motion in a bundled conductor system, sub-span oscillation occurring in more or less horizontal plane is more common and the other three classes are rigid body modes. The leeward conductors that lie in the wake of windward conductors are subjected to forces permitting wind-induced motions to occur. Sub-span oscillation takes the form of single or more loops in sub span between spacer dampers with nodes at or near the spacer damper clamp with elliptical trajectories on more or less the same horizontal plane and mostly windward-leeward pair moving in phase opposition. This occur with low frequency but high amplitude compared to Aeolian vibration causing bending stresses at spacer damper clamping points.

Supreme make Spacer Dampers along with their distribution on the span are designed suitably to take care of sub-span oscillations within safe permissible limits.

3)Galloping:

This happens in case of ice-loading on conductors. When ice deposited on conductor starts melting, initially melting takes place as drop by drop. After some time, a bulk part of ice gets dropped resulting in a reaction force on opposite direction and in most cases in an angular plane. This results in a torsional mode of vibration at low frequency and high amplitude and the conductor starts galloping.

Since galloping will occur in case of ice condition which is not prevailing everywhere, Spacer Dampers are generally designed and developed to take care of Aeolian vibration and Sub-span oscillation.

The following are the problems associated with bundled conductors due to Aeolian vibration and Sub-span oscillation

- Damage of spacers, spacer dampers
- Damage to conductors under the clamps
- Damage to hardware connecting conductor to insulator strings

Spacer damper :

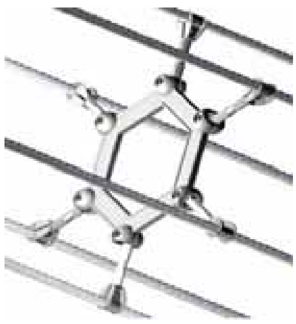
IS:10162-1982 defines Spacer dampers as mechanical components fitted at specified intervals on transmission lines having more than one sub-conductor per phase to perform all functions of a spacer and in addition control Aeolian vibrations and sub-span oscillations within permissible limits.

Construction:

A spacer damper for transmission line cables comprises of a substantially planar frame and a plurality of clamping arms each resiliently pivotally connected to the planar frame at one end and provided with clamping means for respectively grasping individual conductors at the other end. The frame is of rigid one-piece construction and provided at each region of pivotal connection with a recessed portion into which the end of the arm extends so as to lie substantially in the plane of the frame. Each arm is resiliently pivotally connected to the frame by a pair of spaced resilient energy absorbing elements located on either side of the arm to be traversed by the bolt and lockingly engaged with recesses formed in the arm.

Twin Spacer Damper

Quad Spacer Damper



Hexagonal Spacer Damper

The frame is of rigid one-piece construction and provided at each region of pivotal connection with a recessed portion into which the end of the arm extends so as to lie substantially in the plane of the frame. Each arm is resiliently pivotally connected to the frame by a pair of spaced resilient energy absorbing elements located on either side of the arm to be traversed by the bolt and lockingly engaged with recesses formed in the arm.

Each recessed portion of the frame is provided with at least one end cap, itself provided with a recess for lockingly engaging one of the elements, the end cap being rigidly secured to the frame by the locking bolt so as to straddle the recessed portion, hold the elements in compression and thereby secure the arm for resilient hinged part rotation relative to the frame.

Working Mechanism

A spacer damper must incorporate some mechanism that allows large relative movements of one conductor clamp with respect to the other and this mechanism is called articulation.

A spacer damper uses an energy absorption mechanism based on the deformation of elastomer elements. The damping of vibrations is carried out by converting the vibrational energy to stresses in the spacer damper.

Each articulation contains one or more elements which are deformed by the relative movement of the arm with respect to the central frame of the damper. Hence the deformation of the rubber elements results in compressive stresses and shear stresses. However, only one of them dominates depending upon the articulation design. Hence, the construction of the rigid planar structure must be capable of handling the stresses induced due to vibrations of the conductor. The spacer damper has energy absorption capability in both the vertical and horizontal planes to account for both Aeolian vibrations and sub-span oscillations respectively.

Design

The spacer damper shall be designed as per IEC 61854 specifications stated below:

- Maintain subconductor spacing, within any prescribed limits, under all conditions of service excluding short-circuit currents.
- Prevent, in subspans between spacers, physical contact between subconductors, except during the passage of short-circuit currents when the possibility of contact is accepted provided that specified spacing is restored immediately following fault clearance.
- Avoid damage to subconductor under specified conditions.
- To be free from unacceptable levels of corona and radio interference under specified service conditions.
- Withstand mechanical loads imposed on the spacer damper during installation, maintenance and service without any component failure or unacceptable permanent deformation.
- Be suitable for safe and easy installation. For the bolted and latching clamp the design shall retain all parts when opened or attached to the conductor.
- Ensure the individual components do not become loose in service.
- Be capable of being removed and re-installed without damage to spacers or subconductors.
- Maintain its function over entire service temperature range.
- Avoid audible noise.



Testing of Quad Spacer Dampers

On-Line Performance Test on Spacer Damper System

Supreme Spacer Dampers as per their own recommended distribution chart for multi-bundle conductors have been successfully tested on the field span at IREQ, Quebec, Canada under most severe conditions of rain, snow and extreme sub-zero temperature.

Purpose of Test

The purpose of this test on an instrumented full scale test line was to assess the performance of Supreme & Co. Pvt. Ltd.'s quad spacer-damper for Bersimis with respect to the Power Grid Corporation of India Limited (PGCIL) specification regarding aeolian vibrations and subspan oscillations.

Conclusion

The following results were obtained with Supreme & Co. Pvt. Ltd. spacer-dampers installed as per their recommendations on a quad bundle of Bersimis conductors with a nominal tensile load of 34.5 kN:

Every spacer damper was inspected at the end of the test and no displacement of the clamps along the conductor was noticed nor any loosening of components or damage to conductor or spacer damper components.
Consequently, the quad bundle spacer damper for conductor ACSR Bersimis, Supreme & Co. Pvt. Ltd., drawing number 20054P and as per their recommended spacer damper distribution chart meets the entire requirement related to this test as per specification of Power Grid Corporation of India Ltd.

The results of the field tests reported above indicate that the aeolian vibration levels on the bundle are in accordance with the technical specification. The maximum peak-to-peak bending amplitude measured is 100 μm while the acceptable level of bending amplitude for the Bersimis conductor strung at 34.5 kN is 359 μm. In the same manner, the maximum RMS bending amplitude is 20 μm, which is also below the acceptable level of 72 μm according to the PGCIL specification.

The subspan oscillation level reached 233 mm peak-to-peak which is also below the allowable value of 350 mm. The maximum value of frequency times RMS subspan amplitude is 56 mm/s which is below the allowed value of 80 mm/s. A maximum mean fYrms value of of 27.4 mm/s was obtained and this is also below the allowable value of 70 mm/s.
After the test, the whole bundle was inspected and there was no slippage of the spacer dampers or loosening of components or damage to conductors.

Consequently, the quad bundle spacer damper for conductor ACSR Bersimis, Supreme & Co. Pvt. Ltd., drawing number 20054P and as per their recommended spacer damper distribution chart meets the entire requirement related to this test as per specification of Power Grid Corporation of India Ltd.

Quad Spacer Damper

Hex Spacer Damper

On-Line Performance Test on Spacer Damper System at IREQ, Hydro Quebec, Canada

Results Requirements	Results	Requirements
Max. peak-to-peak bending amplitude at clamps	100 m	< 359 m
Max. RMS bending amplitude at clamps	20 m	< 72 m
Max. P-P displacement for subspan oscillations	233 mm	< 350 mm
Max. fYrms for subspan oscillations in each subspan	56 mm/s	< 80 mm/s
Mean fYrms value associated with a given wind sector	27 mm/s	< 70 mm/s

Results Requirements	Results	Requirements
Max. peak-to-peak bending amplitude at clamps	141 m	< 398 m
Max. RMS bending amplitude at clamps	29 m	< 80 m
Max. P-P displacement for subspan oscillations	79 mm	< 350 mm
Max. fYrms for subspan oscillations in each subspan	14 mm/s	< 80 mm/s

City Office

53, Justice Chandra Madhav Road,
Kolkata - 700020, West Bengal, India.
Phone : +91-033-24745984/ 85
Fax : +91-033-24746537 / 24761955
Mail : info@supreme.in/ ho@supreme.in
Website : www.supreme.in

SUPREME
www.supreme.in

SUPREME & CO. PVT. LTD.
ISO 9001: 2008 & 14001: 2004 Certified

Work Office

P-200, Benaras Road,
Howrah - 711108, West Bengal, India.
Phone : +91-033-2651
+91-033-26516701 to 05
Fax : +91-033-26514792/ 6706
Mail : sales@supreme.in

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** These are extracts from complete report. Kindly note that these figures are relevant only in the context of full report. If interested kindly ask for a copy of the full report.