

Type test items on vibration damper are listed in below table:

No.	TEST NAME	APPLICABLE STANDARD	TEST RESULT PASS/FAIL
1	Visual examination, dimensional & material verification test	IEC 61284-1997	
2	Dynamic characteristic test (Damper response test)	As per Vol.-II Technical specification	
3	Vibration analysis test (Damping efficiency test)		
4	Clamp slip test	IEC:61897-1998	
5	Fatigue test	As per Vol.-II Technical specification	
6	Attachment Of Weights To Messenger Cable Test	IEC:61897-1998	
7	Attachments of clamp to messenger cable test	IEC:61897-1998	
8	Clamp bolt tightening test	IEC:61897-1998	
9	Damper effectiveness evaluation test	IEC:61897-1998	

Reference Document:

- 1) Approved DRS & Drawings of OPGW Hardware & Fittings.
- 2) Applicable for OPGW installation hardware & fittings.
- 3) Vol.-II Technical specification.

Sampling Procedure: For vibration damper, at least ten (10) samples shall be offered for selection.

**1. TYPE TEST PROCEDURE OF
VISUAL EXAMINATION, DIMENSIONAL & MATERIAL VERIFICATION TEST**

Test Name: Visual Examination, Dimensional & Material Verification Test

Customer: East North Interconnection Company Limited (ENICL)

Manufacturer:

Standard: ISO 1461-2009 / IEC 61284-1997

Objective: It shall be verified that the samples are in accordance with the relevant drawings, particularly as regards any dimensions to which special tolerance apply and have a sufficient galvanized coating.

Test Procedure:

The following tolerance shall be allowed/on all dimensions to which special tolerance do not apply.

Appearance: To check all and ascertain to be appropriate as per DRS & Drawings.

Dimensions:

(A) Forgings:

- i) Dimensions up to and including 30mm ± 1.5 mm.
- ii) Dimensions greater than 30 mm $\pm 5\%$ upto max. of ± 5 mm.

(B) Helical Fittings:

- i) Dimensions up to and including 30mm ± 1.5 mm.
- ii) Dimensions greater than 30 mm $\pm 5\%$ upto max. of ± 5 mm.

Galvanizing (as per approved DRS & Drawings):

- i) Galvanized coatings shall be tested in accordance with as appropriate.
- ii) All measurements shall be made after galvanizing where galvanizing is the normal finish. Galvanized coatings shall be tested and galvanized coating shall be minimum 85 μ m, except 43 μ m of bolts & nuts.

Acceptance Criteria:

Fittings shall be accordance with their relevant drawings within the tolerance Specified. Galvanized coatings on general articles shall be minimum thickness of 85 μ m, except 43 μ m of bolts & nuts.

OBSERVATIONS, IF ANY:

TEST RESULT: The Hardware Fittings as tested met/did not meet the requirements as preapproved DRS & Drawings.

(Tested by)
Sign & date

(Witnessed by)
Sign & date

**1 TYPE TEST PROCEDURE OF
VIBRATION DAMPER DYNAMIC CHARACTERISTIC TEST (DAMPER RESPONSE TEST)**

Test Name: Dynamic Characteristic Test of Vibration Damper (Damper response test)

Customer: East North Interconnection Company Limited (ENICL)

Manufacturer:

Standard: As per Vol.-II Technical specification

Test Procedure:

The damper shall be mounted with its clamp tightened with torque recommended by the manufacturer on shaker table capable of simulating sinusoidal vibrations for Critical Aeolian Vibration frequency band ranging from $0.18/d$ to $1.4/d$ where d is the OPGW cable diameter in meters. The damper assembly shall be vibrated vertically with ± 1 mm amplitude from 5 to 15 Hz frequency and beyond 15 Hz at 0.5 mm to determine following characteristics with the help of suitable recording instruments.

- (i) Force Vs frequency
- (ii) Phase angle Vs frequency
- (iii) Power dissipation Vs frequency

The Force Vs frequency curve shall not show steep peaks at resonance frequencies and deep troughs between the resonance frequencies. The resonance frequencies were suitably spread within the Aeolian vibration frequency-band between the lower and upper dangerous frequency limits determined by the vibration analysis of fiber optic cable without dampers. The above dynamic characteristics test on five dampers shall be conducted. The variation below the samples tested shall confirm to the sample test limits. The mean reactance and phase angle Vs frequency curves shall be drawn with the criteria of best fit method.

Acceptance criteria:

- (i) The Force Vs frequency curve showing steep speaks at resonance frequencies and deep troughs between the resonance frequencies shall constitute failure.
- (ii) The above mean reactance response curve should lie within following limits:
V.D. for OPGW- $0.060 f$ to $0.357 f$ kgf/mm*
Where f is frequency in Hz.
- (iii) The above mean phase angle response curve shall be between 25° to 130° within the frequency range of interest.
- (iv) Visual resonance frequencies of each mass of damper are to be recorded and to be compared with the guaranteed values.

OBSERVATIONS, IF ANY:

TEST RESULTS:

The Hardware Fittings of OPGW cable met/not met the acceptance criteria for Dynamic Characteristic Test of Vibration Damper.

(Tested by)
Sign & date

(Witnessed by)
Sign & date

2 TYPE TEST PROCEDURE OF VIBRATION ANALYSIS TEST (DAMPING EFFICIENCY TEST)

Test Name: Vibration Analysis Test (Damping efficiency test) for vibration

damper Customer: ENICL

Manufacturer:

Standard: As per Vol.-II Technical specification

TEST PROCEDURE

The vibration analysis of the fiber optic cable shall be done with and without damper installed on the span. The vibration analysis shall be done by means of computer programs using energy balance approach. The following parameters shall be taken into account for the purpose of analysis.

- (a) The analysis shall be done for single fiber optic cable without armour rods. The tension shall be taken as max Permissible Everyday Tension (20% of UTS), for a span ranging from 100 m to 1100 m.
- (b) The self-damping factor and flexural stiffness (EI) for fiber optic cable shall be calculated on the basis of experimental results. The details to experimental analysis with these data shall be furnished.
- (c) The power dissipation curve obtained from Damper Characteristic test shall be used for analysis with damper.
- (d) Examine the Aeolian Vibration level of the fiber optic cable with and without vibration damper installed at the recommended location or wind velocity ranging from 0 to 30 Km per hour, predicting amplitude, frequency and vibration energy input.
- (e) From vibration analysis of fiber optic cable without damper, antinode vibration amplitude and dynamic strain levels at clamped span extremities as well as antinodes shall be examined and thus lower and upper dangerous frequency limits between which the Aeolian vibration levels exceed the specified limits shall be determined.
- (f) From Vibration analysis of fiber optic cable with damper(s) installed at the recommended location, the dynamic strain level at the clamped span extremities, damper attachment point and the antinodes on the fiber optic cable shall be determined. In addition to above damper clamp vibration amplitude and antinodes vibration amplitudes shall also be examined.

ACCEPTANCE CRITERIA

The dynamic strain levels at damper attachment point, clamped span extremities and antinodes shall not exceed the specified limits. The damper clamp vibration amplitude shall not be more than that of the specified fatigue limits.

The dynamic strain levels at damper attachment point are not more than 150 micro-strains (single peak)

OBSERVATIONS, IF ANY:

TEST RESULT:

The Hardware Fittings of OPGW cable met/not met the acceptance criteria for the Damper Analysis test of Vibration Damper.

(Tested by)
Sign & date

(Witnessed by)
Sign & date

3 TYPE TEST PROCEDURE OF VIBRATION DAMPER CLAMP SLIP TEST

Test Name: Clamp slip test of vibration damper

Customer: ENICL

Manufacturer:

Standard: IEC 61897-1998

TEST SET-UP

The Vibration damper clamp slip shall be conducted on a laboratory set up with a minimum effective span length of 30m. The fiber optic cable shall be tensioned at 15 kN and shall not be equipped with protective armour rods at any point.

Constant tension shall be maintained within the span by means of lever arm arrangement. After the fiber optic cable has been tensioned, clamps shall be installed to support the fiber optic cable at both ends and thus influence of connecting hardware fittings are eliminated from the free span. The clamps shall not be used for holding the tension on the fiber optic cable. There shall be no loose parts, such as suspension clamps, U bolts, on the test span supported between clamps mentioned above. The span shall be equipped with vibration inducing equipment suitable for producing steady standing vibration. The inducing equipment shall have facilities for step less speed control as well as step less amplitude arrangement. Equipment shall be available for measuring the frequency, cumulative number of cycles and amplitude of vibration at any point along the span.

TEST PROCEDURE

The vibration damper shall be installed on the test span. The damper clamp, after tightening with the manufacturer's specified tightening torque, when subjected to a longitudinal pull of 2.5 kN parallel to the axis of fiber optic cable for a minimum duration of one minute shall not slip, i.e., the permanent displacement between fiber optic cable and clamp measured after removal of the load shall not exceed 1.0 mm. The load shall be further increased until the clamp starts slipping. The load at which the clamp slips shall not be more than 5 kN.

Clamp slip shall be considered as having occurred when a slip distance of 1 mm is measured.

ACCEPTANCE CRITERIA

No movement of the Vibration damper clamp relative to the conductor greater than 1 mm shall occur at or before the end of application of 2.5 kN for 60 s. If both a minimum and a maximum slip load are stated, the slip shall occur between those values. Surface flattening of the outer strands of the conductor is acceptable.

OBSERVATIONS, IF ANY:

TEST RESULT: The Hardware Fittings of OPGW cable met/not met the acceptance criteria for the Clamp Slip test of Vibration Damper.

(Tested by)
Sign & date

(Witnessed by)
Sign & date

4 TYPE TEST PROCEDURES FOR VIBRATION DAMPER FATIGUE TEST

Test Name: Fatigue test of vibration damper

Customer: ENICL

Manufacturer:

Standard: As per Vol.-II Technical Specification

Objective: To determine the fatigue of vibration damper.

TEST SET-UP

The Vibration damper fatigue test shall be conducted on a laboratory set up with a minimum effective span length of 30m. The fiber optic cable shall be tensioned at 25% UTS of OPGW and shall not be equipped with protective armour rods at any point.

Constant tension shall be maintained within the span by means of lever arm arrangement. After the fiber optic cable has been tensioned, clamps shall be installed to support the fiber optic cable at both ends and thus influence of connecting hardware fittings are eliminated from the free span. The clamps shall not be used for holding the tension on the fiber optic cable. There shall be no loose parts, such as suspension clamps, U bolts, on the test span supported between clamps mentioned above. The span shall be equipped with vibration inducing equipment suitable for producing steady standing vibration. The inducing equipment shall have facilities for step less speed control as well as step less amplitude arrangement. Equipment shall be available for measuring the frequency, cumulative number of cycles and amplitude of vibration at any point along the span.

TEST PROCEDURE

The vibration damper shall be installed on the test span with the manufacturer's specified tightening torque. It shall be ensured that the damper shall be kept minimum three loops away from the shaker to eliminate stray signals influencing damper movement.

The damper shall then be vibrated at the highest resonant frequency of each damper mass. For dampers involving torsional resonant frequencies, tests shall be done at torsional modes also in addition to the highest resonant frequencies at vertical modes. The resonance frequency shall be identified as the frequency at which each damper mass vibrates with the maximum amplitude on itself. The amplitude of vibration of the damper clamp shall be maintained not less than $\pm 25/f$ mm where f is the frequency in Hz.

The test shall be conducted for minimum ten million cycles at each resonant frequency mentioned above. During the test, if resonance shift is observed, the test frequency shall be tuned to the new resonant frequency.

The clamp slip test as mentioned herein above shall be repeated after fatigue tests without re-torquing or adjusting the damper clamp, and the clamp shall withstand a minimum load equal to 80% of the slip strength for a minimum duration of one minute.

After the above tests, the damper shall be removed from fiber optic cable and subjected to dynamic characteristics test, the Graphs showing results for:

General Type Test Procedure-Vibration Damper

- a) Force Vs Frequency
- b) Phase angle Vs Frequency
- c) Power dissipation Vs Frequency

Shall be recorded as per test procedure of Dynamic characteristic test.

There shall not be any major deterioration in the characteristics of the damper. The damper then shall be cut open and inspected. There shall not be any broken, loose, or damaged part. There shall not be significant deterioration or wear of the damper. The fiber optic cable under clamp shall also be free from any damage.

ACCEPTANCE CRITERIA

1. There shall not be any resonant frequency shift before and after the test by more than $\pm 20\%$.
2. The power dissipation of the damper before and after test at the individual resonant frequencies do not differ by more than $\pm 20\%$.

OBSERVATIONS, IF ANY:

TEST RESULT:

The Hardware Fittings of OPGW cable met/not met the acceptance criteria for the Fatigue test of Vibration Damper.

(Tested by)
Sign & date

(Witnessed by)
Sign & date

**5 TYPE TEST PROCEDURE FOR
ATTACHMENT OF WEIGHTS TO MESSENGER CABLE TEST**

Test Name: Attachment of Weights to Messenger Cable Test of Vibration

Damper Customer: ENICL

Manufacturer:

Standard: IEC 61897-1998

Test Procedure:

On an assembled damper a tensile load shall be applied between the weights coaxial with the messenger cable. The load shall be gradually increased (100 N/s maximum) until it reaches 5.0 kN (specified minimum slip load). This load shall be kept constant for 60 s.

The load shall then be increased slowly until one weight has been pulled free of the messenger cable. The maximum load obtained during this process shall be recorded, for information purposes only.

Acceptance Criteria:

No relative movement greater than 1mm between each weight and the messenger cable shall occur at or before the end of the application of 5.0 kN for 60s.

OBSERVATIONS, IF ANY:

Test Results:

The Hardware Fittings of OPGW cable met/not met the acceptance criteria for the Attachment Of Weights To Messenger Cable Of Vibration Damper.

(Tested by)

Sign & date

(Witnessed by)

Sign & date

**6 TYPE TEST PROCEDURE FOR ATTACHMENTS
OF CLAMP TO MESSENGER CABLE TEST**

Test Name: Attachments of Clamp to Messenger Cable Test of Vibration

Damper Customer: ENICL

Manufacturer:

Standard: IEC 61897-1998

Test Procedure:

A tensile load shall be applied between the messenger cable and the clamp body, coaxial with the messenger cable. The load shall be gradually increased (100 N/s maximum) until it reaches 1.5 kN (specified minimum slip load). This load shall be kept constant for 60 s.

The load shall then be increased slowly until the clamp has been pulled free of the messenger cable. The maximum load obtained during this process shall be recorded, for information purposes only.

Acceptance criteria:

No movement of the clamp relative to the messenger cable greater than 1mm shall occur at or before the end of the application of 1.5 kN for 60s.

OBSERVATIONS, IF ANY:

Test Results:

The Hardware Fittings of OPGW cable met/not met the acceptance criteria for Attachments of Clamp To Messenger Cable Test.

(Tested by)

Sign & date

(Witnessed by)

Sign & date

7 TYPE TEST PROCEDURE FOR CLAMP BOLT TIGHTENING TEST OF VIBRATION DAMPER

Test Name: Clamp Bolt Tightening Test of Vibration Damper

Customer: ENICL

Manufacturer:

Standard: IEC 61897-1998

Test Procedure:

The test shall be performed using the conductor for which the clamp is intended to be used. The bolt(s) or nut(s) shall be tightened to a torque 10 % above the specified installation torque.

Lastly, the torque shall be increased to twice the specified installation torque. This increase shall not result in any breakage of threaded parts or other components.

Acceptance criteria:

Regarding 1.1 times torque, the test is passed if the threaded connection remains serviceable for any number of subsequent installation or removals, and all components comprising the clamp are undamaged.

Regarding 2 times, the test is passed if any breakage either to threaded parts or to the components connected to them does not occur.

OBSERVATIONS, IF ANY:

Test Results:

Damper No.	1.1 times torque Comment on condition of components	2 times torque Comment on condition of components
1		
2		
3		

The Hardware Fittings of OPGW cable met/not met the acceptance criteria for Clamp Bolt Tightening Test of Vibration Damper.

(Tested by)

Sign & date

(Witnessed by)

Sign & date

8 TYPE TEST PROCEDURE FOR DAMPER EFFECTIVENESS EVALUATION TEST OF VIBRATION DAMPER

Test Name: Damper effectiveness Evaluation Test of Vibration

Damper Customer: ENICL

Manufacturer:

Standard: IEC 61897-1998

Test Procedures

The damping efficiency test shall be conducted on a laboratory set up with a minimum free span length of 30m. Install the OPGW on the test span, and the OPGW shall be tensioned at Everyday Stress (20% of UTS).

A rigid clamp shall be installed to support rigidly (but not to tension) the OPGW at both ends of the span and the damper and shaker shall be positioned in figure 1. The shaker shall be installed in such a way that its connection to the OPGW cable is located in the first loop for all frequencies to be employed.

The damper or dampers shall be installed in accordance with manufacturer recommendations, unless specified. OPGW bending strain shall be monitored adjacent to the rigid clamp at the span end with the damper(s) and to both sides of the clamp of each damper. Two strain gauges shall be attached to the OPGW at each of the three positions: one each on the two uppermost strands and as close as practicable to, but not more than 2 mm from the last point of contact of the rigid clamp with strands and 5 mm from the last point of contact of the damper clamp with strands.

The test span shall be excited to achieve stable cable motion at the frequencies for which resonance occurs within the range $0.18/d \sim 1.4/d$, where d is the OPGW diameter in metre. A maximum of 20 tune able frequency span resonances shall be tested, they shall be reasonably spaced over the frequency range indicated above.

Adjust the input power at each tune able frequency until the highest of the strain readings corresponds to 150 micro-strains (single peak).

At each of these test frequencies the following shall be recorded:

- a) Frequency.
- b) OPGW Bending strain.
- c) Power Input P_j from the shaker.
- d) OPGW antinode peak-to-peak amplitude Y_j in one of the loops near the damper.

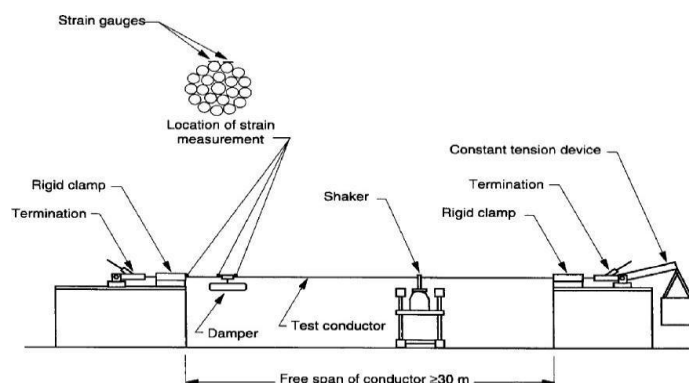


Figure 1-Test for laboratory test of damper effectiveness

Acceptance Criteria

For each test frequency the power input P_j during the test shall exceed the assumed wind power input $P_{w,j}$ which shall be calculated from the equation:

$$P_{w,j} = L \cdot d^4 \cdot f_j^3 \cdot f_n(Y_j/d)$$

Where,

L is the maximum protectable conductor span length for the damper arrangement under test as agreed between purchaser and supplier (m);

d is the OPGW diameter (m);

f_j is the frequency (Hz);

Y_j the conductor antinodes peak-to-peak amplitude (m);

$f_n(Y_j/d)$ is the wind power input function;

OBSERVATIONS, IF ANY:

Test Results:

The Hardware Fittings of OPGW cable met/not met the acceptance criteria for Attachments of Clamp to Messenger Cable Test.

(Tested by)

Sign & date

(Witnessed by)

Sign & date