# IEC 61196-1-314

Edition 2.0 2015-08

# INTERNATIONAL STANDARD

## Coaxial communication cables –
## Part 1- 314: Mechanical test methods – Test for bending

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International Standard IEC 61196-1-314 has been prepared by subcommittee 46A: Coaxial cables, of IEC technical committee 46: Cables, wires, waveguides, R.F. connectors, R.F. and microwave passive components and accessories.

This second edition cancels and replaces the edition published in 2006. This edition constitutes a technical revision. This edition includes the following significant technical change with respect to the previous edition:

– Clause 4 (single bending test) was completely revised.

The text of this standard is based on the following documents:

| FDIS | Report on voting |
|---|---|
| 46A/1264/FDIS | 46A/1269/RVD |

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

This standard is intended to be read in conjunction with IEC 61196-1:2005, on which it was based.

A list of all parts in the IEC 61196 series, under the general title: *Coaxial communication cables*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

# COAXIAL COMMUNICATION CABLES –

# Part 1- 314: Mechanical test methods – Test for bending

## 1 Scope

This part of IEC 61196 applies to coaxial communications cables. It specifies test methods to determine the bending tests for cables:

- bending around a test mandrel (Clause 4);
- repeated bending (Clause 5);
- repeated flexing in service (Clause 6);
- flexing in service (Clause 7);
- bending around rollers or bows during installation (Clause 8);

and for

- measuring the stiffness (Clause 9) of such a cable;
- kink test (Clause 10).

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050 (all parts), *International Electrotechnical Vocabulary,* available at http://www.electropedia.org/

IEC 61196-1, *Coaxial communication cables – Part 1: Generic specification – General, definitions and requirements*

EN 50289-3-1, *Communication cables – Specifications for test methods – Part 3-1: Mechanical test methods – General requirements*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050 and in IEC 61196-1 apply.

## 4 Bending around a test mandrel

### 4.1 Equipment

A single mandrel apparatus shall enable the sample to be wrapped tangentially in a close helix around a test mandrel.

### 4.2 Test sample

The sample shall be terminated at each end by suitable connectors.

### 4.3 Procedure

#### 4.3.1 General

As indicated in the sectional or detail specification, one of the following two procedures detailed in 4.3.2 and 4.3.3 shall be used.

#### 4.3.2 Procedure 1

The sample shall be wrapped in a close helix around the mandrel at a uniform rate. Sufficient tension shall be applied to ensure that the sample contours the mandrel. The sample shall then be unwrapped.

The test consists of one wrapping and one unwrapping.

The diameter of the test mandrel and the number of turns per helix shall be shown in the sectional or detail specification.

#### 4.3.3 Procedure 2

The sample shall be bent around a mandrel through 180° and kept taut during the bending. The test consists of one U bend followed by a reverse U bend, and returned to the straight position. The diameter of the test mandrel shall be stated in the sectional or detail specification.

#### 4.3.4 Requirements

The acceptance criteria for the test shall be stated in the sectional or detail specification. Typical failure modes include loss of electrical continuity, degradation of transmission performance or physical damage to the cable.

#### 4.3.5 Test report

The test report shall include:

a) procedure to be used (procedure 1 or procedure 2);
b) test mandrel diameter (or ratio of mandrel diameter to cable diameter);
c) number of turns (for procedure 1);
d) maximum allowable attenuation increase:
    1) during the test (if applicable);
    2) after the test (if applicable);
e) test temperature;
f) pass/fail criteria.

## 5 Repeated bending

### 5.1 Equipment

The apparatus shall permit a sample to be bent backwards and forwards through angles up to 180°, the two extreme positions making an angle of 90° on both sides of the vertical, whilst being subjected to a tensile load. For testing cables, a suitable apparatus is shown in Figure 1. For testing cable/connector assemblies, a suitable apparatus is shown in Figure 2. Other equivalent apparatus may be used.

The bending arm shall have an adjustable clamp of fixture to permit holding the cable securely during the entire test. For connectorized cables, a connector may be used to hold the cable on the bending arm providing that its characteristics fit with the tensile load.

The apparatus shall be capable of cycling. Displacing the sample from the vertical position to the extreme right position then oscillating to the extreme left position and returning to the original vertical position is considered to be one cycle. Unless otherwise specified in the sectional or detail specification, the bending rate shall be approximately one cycle in 2 s.

The apparatus shall include any test equipment needed to measure the changes in transmission performance requested in the sectional or detail specification.

### 5.2 Test sample

#### 5.2.1 Sample length

The sample length shall be sufficient to carry out the testing specified. When only physical damage is to be evaluated, the length may range from 1 m (for example for small diameter jumper cords) to 5 m (for larger diameter cables). Longer lengths may be necessary to permit transmission measurements.

#### 5.2.2 Termination

The sample may be terminated at each end in a connector, or in a representative manner. The clamps on the bending apparatus may be adequate, or the sample may be long enough that no restraint is needed.

### 5.3 Procedure

The procedure can be defined in five steps.

a) Precondition sample at standard atmospheric conditions for 24 h.

b) Apply the weight of mass as shown in the sectional or detail specification.

c) Measure acceptance criteria parameters to establish baseline values.

d) Carry out repeated bending for the number of cycles specified in the sectional or detail specification.

e) Carry out acceptance criteria parameter measurements. If necessary, the sample may be removed from the apparatus for visual examination.

### 5.4 Requirements

The acceptance criteria for the test shall be stated in the sectional or detail specification. Typical failure modes include loss of transmission performance of physical damage to the cable.

### 5.5 Test report

The test report shall include:

a) the angle of displacement;

b) number of cycles;

c) mass of the weight;

d) bending radius $R$;

e) test temperature;

f) pass/fail criteria.

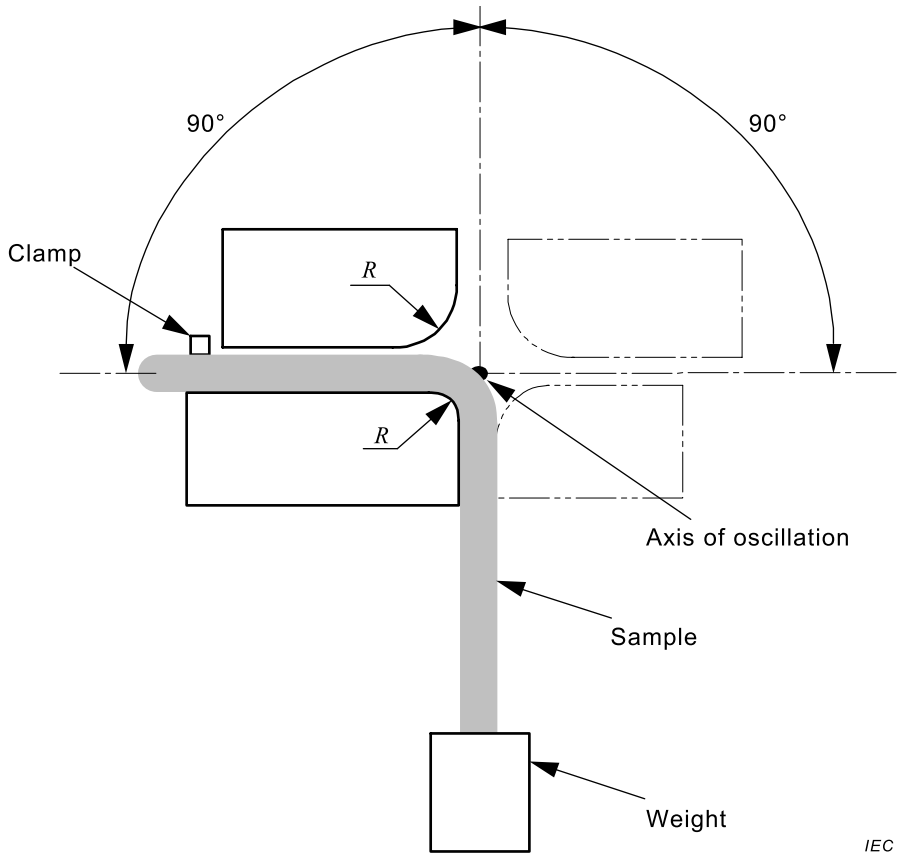



**Figure 1 – Repeated bending test for cable**

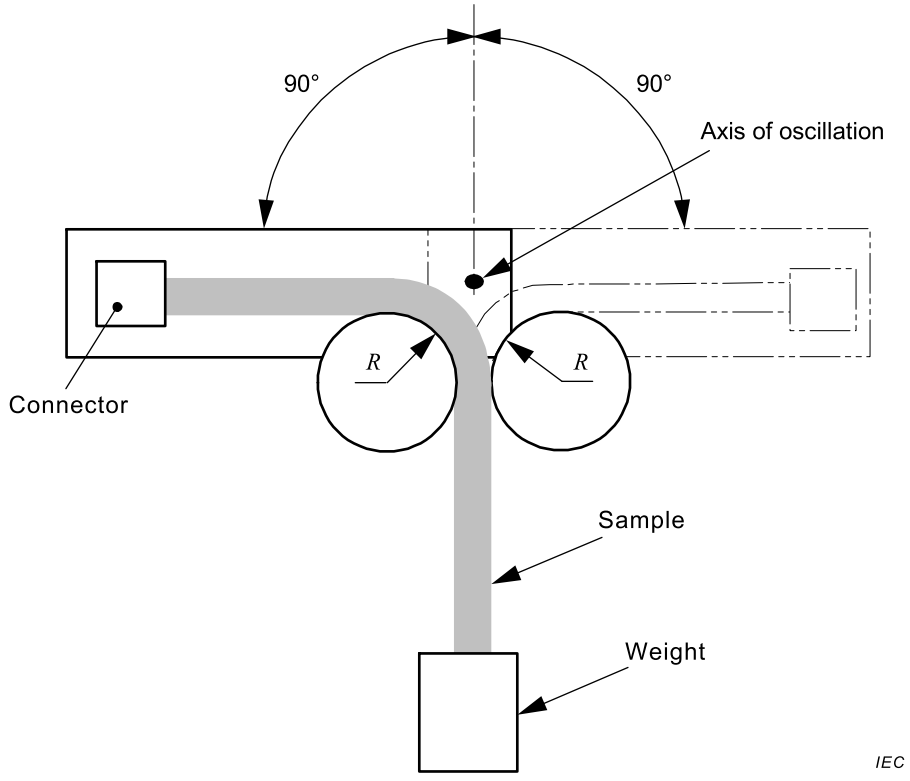



**Figure 2 – Repeated bending test for cable/connector assembly**

# 6 Flexing

## 6.1 Equipment

The test is carried out using the apparatus shown in Figure 3.

The pulleys shall have a semicircular shaped groove for circular cables and a flat groove for flat cables. The restraining clamps D shall be fixed so that the pull is always applied by the weight from which the carrier is moving away.

## 6.2 Test sample

The sample shall be terminated at each end in a connector, or in a representative manner. The length of the sample shall be sufficient to carry out the testing specified.

## 6.3 Procedure

The sample shall be stretched over the pulleys, each end being loaded with a weight. The mass of this weight and the diameter of the pulleys A and B shall be as specified in the sectional or detail specification.

The sample shall be flexed for the number of cycles specified in the sectional or detail specification. A cycle is defined as the movement of the carriage away from its starting position to one end of the traverse followed by movement in the opposite direction to the other end and then back to the starting position.

## 6.4 Requirements

The acceptance criteria for the test shall be stated in the sectional or detail specification. Typical failure modes include loss of transmission performance or physical damage to the cable.

## 6.5 Test report

The test report shall include:

a) diameter of pulleys A and B;
b) mass of weights;
c) number of cycles;
d) test temperature;
e) pass/fail criteria.

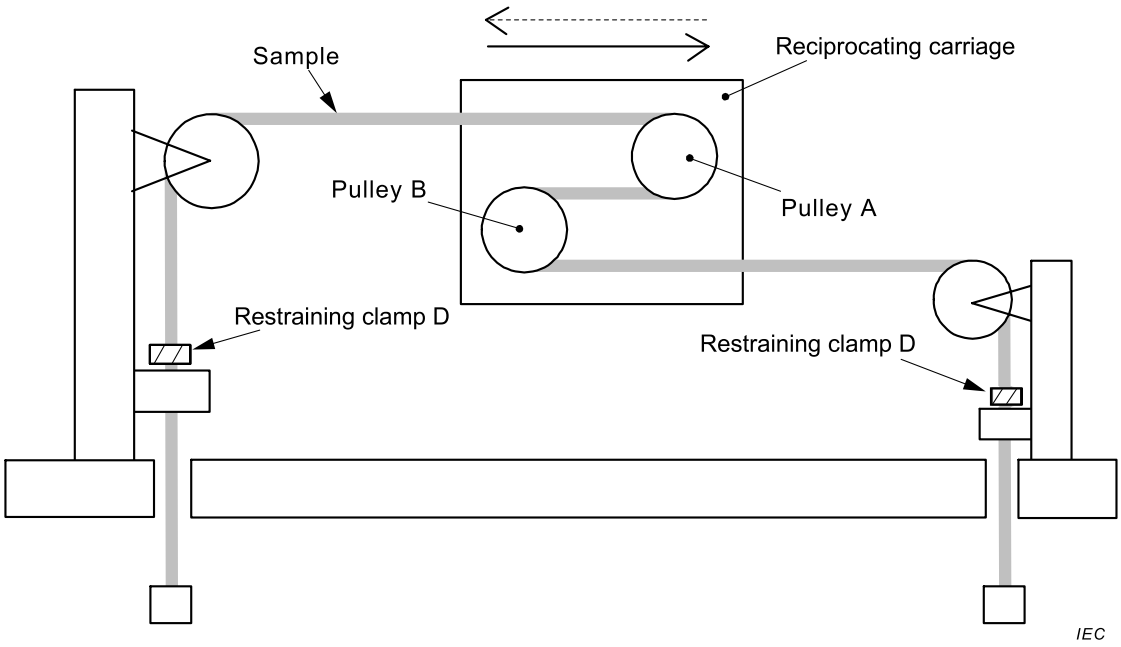



**Figure 3 – Flexing apparatus**

## 7 Flexing endurance

### 7.1 Equipment

The test is carried out using the apparatus shown in Figure 4.

### 7.2 Test sample

The sample shall be taken from one end of a finished cable.

The sample shall be terminated at each end in a connector, or in a representative manner. The length of the sample shall be sufficient to carry out the testing specified.

The maximum length of cable assembly should be less than 2 m.

### 7.3 Procedure

The cable shall be placed on a horizontal table in an apparatus as illustrated in Figure 4.

Whilst one end is fixed, the other end is moved back and forth in the direction of the cable axis.

### 7.4 Requirements

After the test, the cable shall show no visible damage. Electrical requirements stated in the sectional or detail specification shall be complied with.

### 7.5 Test report

The test report shall include:

a) movement amplitude, normally half the length of the assembly;

b) number of cycles, normally 500;

c) electrical tests or optical tests to be applied with requirements;

d) test temperature;

e) pass/fail criteria.

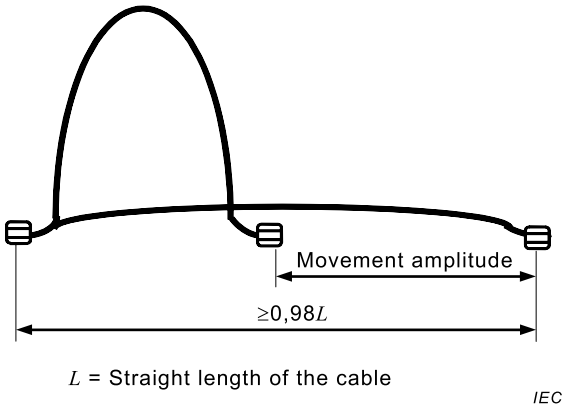



**Figure 4 – Apparatus for cable flexing endurance test**

## 8 Cable bending under tension (dynamic test)

### 8.1 Equipment

The apparatus consists of

a) tensile power device with a maximum error of ±3 %;

b) if required for a particular user application, attenuation measuring apparatus for the determination of attenuation change and/or fibre elongation strain measuring apparatus;

c) for procedure 1: one roller with a radius, $r$, as given in the sectional or detail specification and as shown in Figure 5;

d) for procedure 2: two rollers with a radius $R$, distance $Y$, and a bending angle, $\varphi$, as given in the sectional or detail specification and as shown in Figure 6.

### 8.2 Test sample

The sample shall be taken from one end of a finished cable, without cutting if specified in the sectional or detail specification.

Both ends of the specimen shall be terminated in such a way that the specified load can be applied.

If transmission tests are requested, the samples shall be fitted with suitable terminations.

The sample shall be marked at points A and B as shown in Figures 5 and 6.

### 8.3 Procedure

#### 8.3.1 General

The test shall be carried out at ambient temperature.

If specified in the sectional or detail specification, the attenuation shall be recorded before the specified load is applied, and after the test when the load is zero.

Depending on the installation method, and as indicated in the sectional or detail specification, one of the two procedures detailed in 8.3.2 and 8.3.3 shall be used.

### 8.3.2 Procedure 1

Procedure 1 is as follows.

a) The cable shall be moved around a cylinder or on a device as specified in the sectional or detail specification, through a minimum of 180° (U-bend) as shown in Figure 5, or according to other values agreed between user and manufacturer.

b) The tension shall be continuously increased to the required value given in the sectional or detail specification.

c) The cable shall be moved from point A to point B (see Figure 5) and then returned to point A, with a speed and in a number of cycles as specified in the sectional or detail specification.

### 8.3.3 Procedure 2

Procedure 2 is as follows.

a) The cable shall be bent around two cylinders in an S form manner (S-bend), or on a device as specified in the sectional or detail specification, as shown in Figure 6.

b) The tension shall be continuously increased to the required value given in the sectional or detail specification.

c) The cable shall be moved from point A to point B (see Figure 6) and then returned to point A, with a speed and in a number of cycles as specified in the sectional or detail specification. Instead of moving the cable from point A to point B, the rollers may be moved over the cable length under test

## 8.4 Requirements

Under visual examination without magnification, there shall be no significant damage to the sheath and/or to the cable elements.

If specified, any permanent increase in attenuation after the test shall not exceed the value specified in the sectional or detail specification.

Further detailed requirements should be given in the sectional or detail specification.

## 8.5 Test report

The test report shall include:

a) procedure used (1 or 2);

b) length of the cable and length bent under tension;

c) end preparation;

d) tension device;

e) radius, $r$, of rollers in procedure 1;

f) radius, $R$, of rollers / cylinders / mandrels in procedure 2;

g) distance, $Y$, in procedure 2;

h) bending angle, $\varphi$, in procedure 2;

i) moving speed;

j) number of moving cycles;

k) maximum fibre strain during the test, if specified;

l) elongation of sheath, if required;

m) launching conditions and attenuation measuring device, if relevant;

n) the electrical parameters, if specified, of conductors incorporated in the cable design;

o) maximum tension applied during test;

p) test temperature;

q) pass/fail criteria.

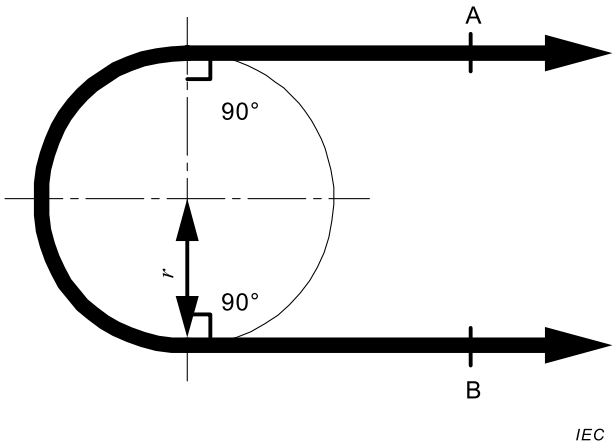



**Figure 5 – U-bend**

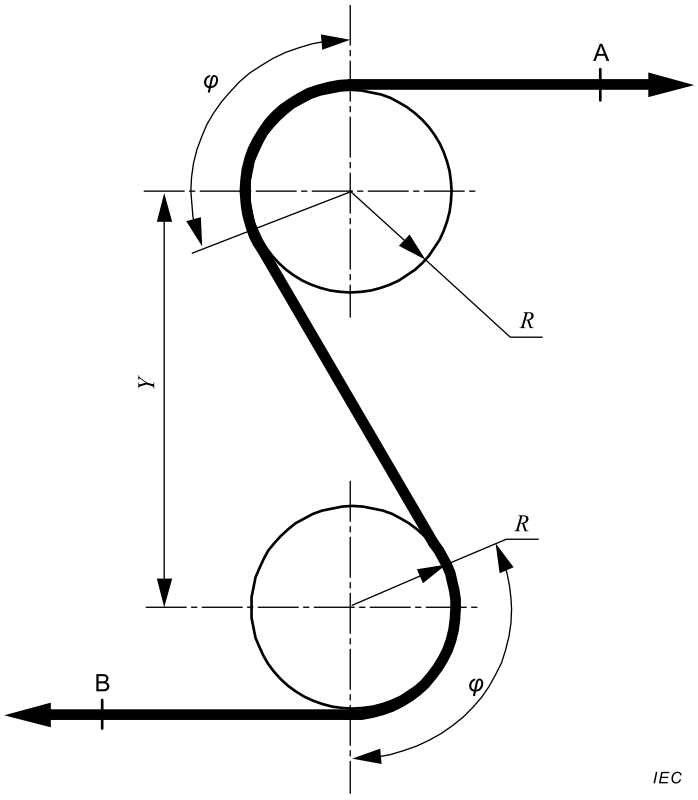



**Figure 6 – S-bend**

## 9 Stiffness

### 9.1 General

Three alternative methods are applicable, depending on the type of cable.

Stiffness is a parameter used to evaluate the performance of a cable when installed using conventional pulling techniques (for example, in ducts, trunking, conduit or under floors) and

also when using blowing techniques. Stiffness is also used to ensure that jumper and indoor cables are sufficiently rugged yet flexible enough to withstand installation and normal usage.

- Methods A and B are suitable for large cables.
- Method B is also suitable for smaller cables including lightly armoured cables and indoor cables.
- Method C is suitable for small cables such as ruggedized single-fibre cables.

## 9.2 Equipment

### 9.2.1 Method A

The three point bending test set-up is shown in Figure 7. The sample is placed on two supports which allow free movement of the cable (for example, the supports may be rotating bars). Means shall be provided to apply a force to the sample at a point midway between the supports and to measure the subsequent displacement.

### 9.2.2 Method B

The cantilever test set-up is shown in Figure 8.The sample is secured in a clamp and means shall be provided to apply a force to the end of the sample remote from the clamp, and to measure the subsequent displacement.

In some cases (for example, small jumper cables), the clamp can be designed to control the bending radius of the sample, as shown in Figure 8b).

### 9.2.3 Method C

The test set-up is shown in Figure 9. It provides a means of measuring the force imparted by the test sample when bent into a U-bend. A suitable apparatus is a tensile testing machine fitted with a load cell and capable of maintaining a given jaw separation for a specified duration.

## 9.3 Test sample

The sample length shall be sufficient to carry out the specified test.

## 9.4 Procedure

### 9.4.1 Method A

Set the supports at a distance apart as specified in the sectional or detail specification. The test sample is placed on the supports, the force applied and the displacement measured.

The sample shall be longer than the distance between the supports by an amount that ensures that any internal movement of the cable components does not affect the result.

The force can be applied by a blade fixed to a tensile testing machine or by weights hooked to the cable.

If a force $F$ (in newtons) results in a displacement $y$ (in metres) with the supports $x$ (in metres) apart, the stiffness $B$ is:

$$B = \frac{x^3}{48}\frac{F}{y}\left(\mathrm{Nm}^2\right)$$

Since some cables (for example, armoured cables) can exhibit a change in behaviour from elastic to inelastic, as shown in Figure 10, it is preferable for the force to be increased in increments so that the point of any change can be identified. The stiffness to be specified is the elastic stiffness which is given by:

$$B = \frac{x^3}{48} \tan\alpha \left(\mathrm{Nm}^2\right)$$

### 9.4.2 Method B

Fix the sample securely in the clamp, apply the force and measure the displacement.

The force can be applied by a tensile testing machine or by weights.

The sample length shall be selected to ensure that any internal movement of the cable components does not affect the result.

If the maximum force $F$ (in newtons) results in a displacement $y$ (in metres) with a span length $\ell$ (in metres), the stiffness $B$ is:

$$B = \frac{\ell^3}{3} \frac{F}{y} \left(\mathrm{Nm}^2\right)$$

or

$$B = \frac{\ell^3}{3} \tan\alpha \left(\mathrm{Nm}^2\right)$$

### 9.4.3 Method C

The sample is fixed to the apparatus in a straight condition. The jaw separation is reduced to a value given by $s \times d$, where d is the cable diameter and s is the separation factor given in the sectional or detail specification. After the duration specified in the sectional or detail specification, the force imparted by the test sample is recorded.

The stiffness $B$ is then:

$$B = F \times \pi \times \mathrm{r}^2 \left(\mathrm{Nm}^2\right)$$

where

$F$ is the measured force in newtons (N);

$r$ is the bend radius in metres (m) of cable at final jaw separation.

## 9.5 Requirements

The cable stiffness shall meet the requirements specified in the sectional or detail specification.

## 9.6 Test report

The test report shall include:

a) cable type;
b) distance between supports;
c) maximum force;
d) sample length;
e) number of samples tested;
f) loading rate (method A);
g) cable span ($\ell$) (method B);
h) bend radius (method B)
i) separation factor ($s$) (method C);
j) duration of test (method C);
k) test temperature;
l) pass/fail criteria.

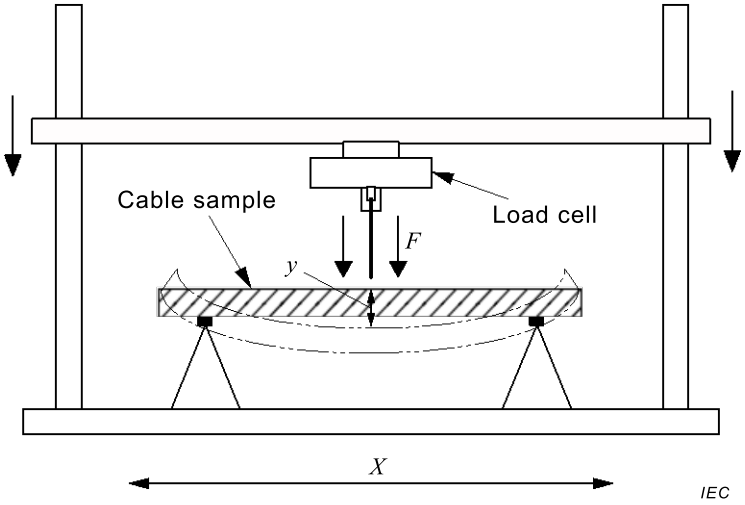
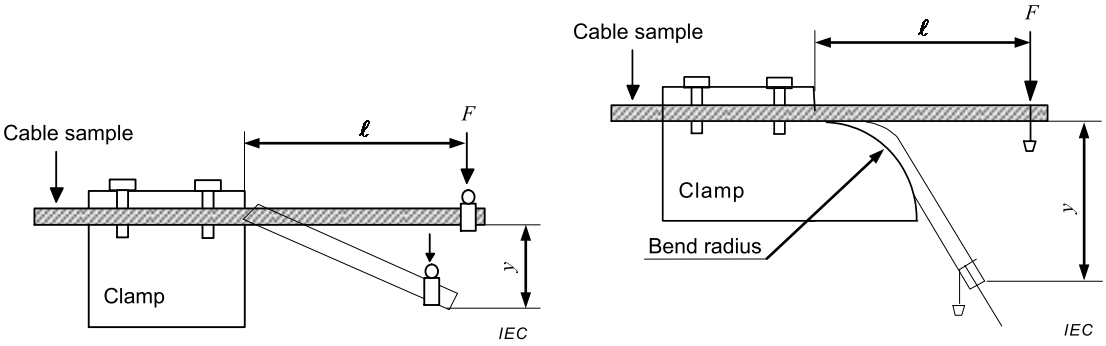



**Figure 7 – Test set-up for method A: Three point bending test**




**a) Before bend** **b) During bend**

**Figure 8 – Test set-up for method B: Cantilever test**

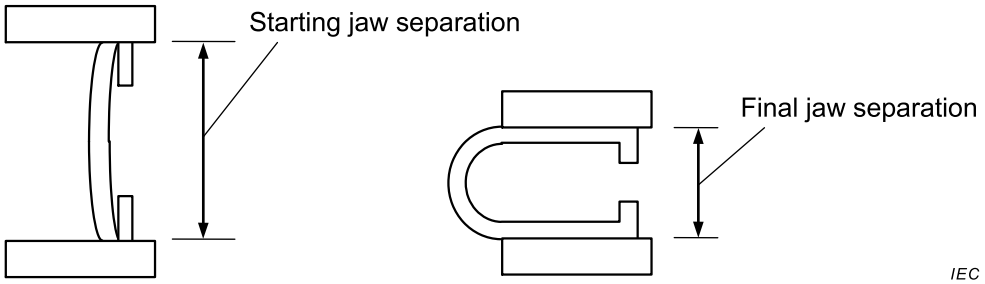



**Figure 9 – Test set-up for compression force**

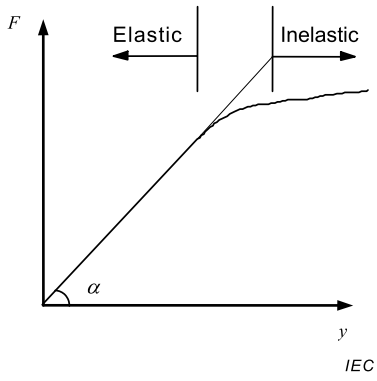



**Figure 10 – Example of results of applied force and displacement**

## 10 Kink test

### 10.1 Sample

The sample length shall be sufficient to carry out the specified test.

### 10.2 Equipment

No particular apparatus is required.

### 10.3 Procedure

A loop shall be made (see (1) in Figure 11). The diameter of the loop shall be reduced to the onset of kinking by pulling slowly on the two ends (see (2) in Figure 11). The forces at the bottom of the loop shall be applied in one plane.

Unless otherwise specified, the conditions for testing shall be in accordance with EN 50289-3-1.

### 10.4 Requirement

No kink shall occur (see (3) in Figure 11).

### 10.5 Test report

The test report shall include:

a) minimum loop diameter at which no kink shall occur;

b) test temperature;

c) pass/fail criteria.

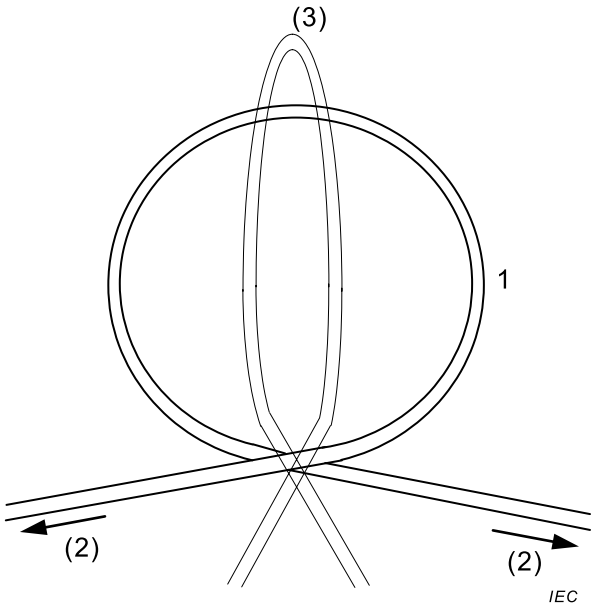



**Figure 11 – Kink test**

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