OPTICAL FIBER CABLE

TECHNICAL FIELD OF THE INVENTION

[0001]

This invention relates to an optical fiber cable in which a plurality of optical fiber strands are bonded in parallel.

BACKGROUND OF THE INVENTION

[0002]

As an optical fiber for transmitting numerous data at high speed, an optical fiber ribbon in which a plurality of optical fiber strands are arranged and bonded in parallel is used for simple cable storage and operation. In some optical fiber ribbons, parallel optical fiber strands are fixed and bonded by resin over the full length thereof. In other optical fiber ribbons, optical fiber strands are bonded to each other intermittently (Patent Document 1, for example).

RELATED ART

PATENT DOCUMENTS

[0003]

[Patent Document 1] Japanese Unexamined Patent Application Publication No.2010-8923 (JP-A-2010-8923)

SUMMARY OF THE INVENTION

(PROBLEMS TO BE SOLVED BY THE INVENTION)

[0004]

With these intermittently bonded optical fiber ribbons, no large strain is given to the optical fiber ribbons when the optical fiber cable, which is packaged densely with optical fibers, is bent. This is because the optical fiber ribbon can move freely as a single core at the non-connected sections of the intermittently bonded optical fiber tape that is packaged in the cable.

[0005]

However, the inventor of the present invention have found out that, when a plurality of the intermittently bonded optical fiber ribbons are inserted into a cable, the motion of the optical fiber ribbons may be impeded, depending on the positions of the bonding sections.

[0006]

More particularly, it has been found out that, when the positions of the connected sections of the optical fiber ribbons overlap with each other completely, the motion of the optical fiber ribbons, which configures the intermittently bonded optical fiber tape, is impeded, deteriorating transmission characteristics.

[0007]

Embodiments of the present invention seek to address such problems and to provide an optical fiber cable that includes intermittently bonded optical fiber ribbons and has excellent transmission characteristics.

(MEANS FOR SOLVING PROBLEMS)

[0007a] According to an aspect of the present invention, there is provided an optical fiber cable comprising: a plurality of optical fiber ribbons which are to be accommodated in the optical fiber cable; and a coat layer that protects a plurality of the optical fiber ribbons, wherein: each of the optical fiber ribbons is formed such that a plurality of optical fiber strands are arranged in parallel and integrated; adjacent optical fiber strands are bonded intermittently with each other along the longitudinal direction of the optical fiber strands; and positions, in the longitudinal direction, of corresponding bonding sections in adjacent optical fiber ribbons, are shifted with respect to each other.

[0008]

There is disclosed is an optical fiber cable including a plurality of optical fiber ribbons and a coat layer that protects a plurality of the optical fiber ribbons. The optical fiber ribbon is formed of a plurality of aligned optical fiber strands. The adjacent optical fiber strands are bonded intermittently with each other along the longitudinal direction of the optical fiber strands, and positions of bonding sections of each of a plurality of the optical fiber ribbons, which are to be accommodated in the optical fiber cable, in the longitudinal direction of the optical fiber cable are shifted from each other.

[0009]

When an end position of any one of bonding sections of a standard optical fiber ribbon, which is arbitrarily selected from a plurality of the optical fiber ribbons, is called as a standard bonding-section position and, for each of the other optical fiber ribbons, the end position of the bonding section that is closest to the standard

bonding-section position in the longitudinal direction of the optical fiber cable is called as a bonding-section position respectively, it is preferable that a range of shifting in the longitudinal direction of the optical fiber cable of the bonding-section positions, including the standard bonding-section position and all the respective bonding-section positions, is greater than or equal to half the length of the bonding section.

[0010]

It is preferred that the bonding-section positions of at least one pair of the optical fiber ribbons in the longitudinal direction of the optical fiber cable do not overlap with each other.

[0011]

When a plurality of the optical fiber ribbons

are accommodated, the positions of the bonding section thereof in the longitudinal direction do not coincide with each other completely, and thus restraining force of each of the optical fiber ribbons is weak, preventing application of stress from being concentrated at one place.

[0012]

In addition, if the maximum shifting distance between the bonding-section positions, including the standard bonding-section position and all the respective bonding-section positions, is greater than or equal to half the length of the bonding section, the restraint between each of the optical fiber ribbons can be further suppressed.

[0013]

Furthermore, the bonding-section positions of at least one pair of the optical fiber ribbons in the longitudinal direction do not overlap with each other so that interference between the bonding sections is suppressed and the restrain on the optical fiber strands can be further suppressed.

(EFFECTS OF THE INVENTION)

[0014]

Embodiments of the present invention can provide an optical fiber cable that includes intermittently bonded optical fiber ribbons and has excellent transmission characteristics.

BRIEF DESCRIPTION OF DRAWINGS

[0015]

FIG. 1 is a cross sectional view showing an optical fiber cable 1.

FIG. 2 is a drawing showing optical fiber ribbons 3a, 3b, 3c, 3d, and 3e.

FIG. 3 is a drawing showing the optical fiber ribbons 3a, 3b, 3c, 3d, and 3e.

FIG. 4 is a drawing showing the optical fiber ribbons 3a, 3b, 3c, 3d, and 3e.

FIG. 5 is a drawing showing the optical fiber ribbons 3a and 3b.

DESCRIPTION OF SOME EMBODIMENTS

[0016]

Hereinafter, embodiments of the present invention will be described with reference to the accompanying drawings. FIG. 1 is a cross sectional view showing an optical fiber cable 1. The optical fiber cable 1 mainly includes optical fiber ribbons 3, a buffer layer 5, a coat layer 7, tension members 9, ripcords 11, and so on.

[0017]

The optical fiber ribbon 3 is an optical fiber ribbon in which a plurality of optical fiber strands are arranged in parallel and integrated. The optical fiber ribbon 3 will be described in detail later.

[0018]

The buffer layer 5 is provided on the outer periphery of the optical fiber ribbons 3. The buffer layer 5 protects the optical fiber ribbons 3 from external force and the like.

[0019]

The coat layer 7 is formed on the outer periphery of the buffer layer 5. The coat layer 7 is a layer to coat and protect the optical fiber cable 1. The tension members 9 are provided inside the coat layer 7.

[0020]

The tension members 9 are subjected to tensile force of the optical fiber cable 1. The tension members 9 are formed of, for example, steel wires or fiber reinforced plastics. In addition, ripcords 11 are embedded in the coat layer 7 if necessary.

[0021]

The problem to be solved by the present invention arises notably when a ratio of the area occupied by fibers in a cable is high. Usually, in manufacturing a cable, the ratio of the area occupied by fibers (the ratio that cross sections of optical fibers occupy in the total cross section) is raised as much as possible to gain high space utilization, so the ratio of area occupied by optical fibers is 50 % or more. The effect of the present invention can be obtained when applied to all these optical fibers that have 50 % or more of the ratio of area occupied by optical fibers.

[0022]

The optical fiber cable according to the present invention is not limited to the example shown in the drawing. The present invention can be applied to other types of optical fibers, such as loose tube cables, in which a tension member is arranged at the center, or slot type optical fibers.

[0023]

FIG. 2 is a perspective view showing a plurality of the optical fiber ribbons 3 (hereinafter, optical fiber ribbons 3a, 3b, 3c, 3d, and 3e, respectively). Although the example shown in the drawing shows a state in which a plurality of the optical fiber ribbons 3a, 3b, 3c, 3d, and 3d are aligned, the directions and arrangement of each of the optical fiber ribbons 3a, 3b, 3c, 3d, and 3d are not uniform as shown in FIG. 1.

[0024]

Also, although only five of the optical fiber ribbons 3a, 3b, 3c, 3d, and 3e will be described below as an example for simplifications, the descriptions below are to be applied to all the optical fiber ribbons 3 that are to be accommodated in the optical fiber cable 1.

[0025]

Also, although the example in the descriptions hereinafter shows the optical fiber ribbons 3a, 3b, 3c, 3d, and 3e each of which is formed of four optical fiber strands 13, the present invention is not limited thereto and can be applied to any of the optical fiber ribbon formed of a plurality of the optical fiber strands.

[0026]

Each of the optical fiber ribbons 3a, 3b, 3c, 3d, and 3e includes a plurality of the optical fiber strands 13 bonded in parallel.

[0027]

In the optical fiber ribbons 3a, 3b, 3c, 3d, and 3e, the adjacent optical fiber strands 13 are intermittently bonded to each other at bonding sections 15 that are spaced at predetermined intervals. The bonding sections 15 between the adjacent optical fiber strands are positioned so as to be shifted from each other in the longitudinal direction of the optical fiber ribbons 3a, 3b, 3c, 3d, and 3e. For example, it is preferable that the bonding sections 15 adjacent to each other are formed so as to be shifted half a pitch in the longitudinal direction of the optical fiber ribbons 3a, 3b, 3c, 3d, and 3e.

[0028]

FIG. 3 is a plan view showing the optical fiber ribbons 3a, 3b, 3c, 3d, and 3e that are arranged side by side. The direction A in FIG. 3 is the longitudinal direction of the optical fiber cable 1. That is, FIG. 3 is a drawing showing the positions of the bonding sections 15 of each of the optical fiber ribbons 3a, 3b, 3c, 3d, and 3e in the longitudinal direction. Thus, the direction perpendicular to A in FIG. 3 indicates the same position along the longitudinal direction of the optical fiber cable 1.

[0029]

The bonding sections 15 of the optical fiber ribbons 3a, 3b, 3c, 3d, and 3e all have the same length and are at the same pitch. In addition, for each of the optical fiber ribbons 3a, 3b, 3c, 3d, and 3e, the adjacent bonding sections 15 are shifted half the pitch from each other.

[0030]

In the present invention, the positions of the bonding sections 15 of all the optical fiber ribbons 3a, 3b, 3c, 3d, and 3e are shifted from each other in the

longitudinal direction. That is, the positions of the bonding sections 15 of the optical fiber ribbons 3a, 3b, 3c, 3d, and 3e in the longitudinal direction never coincide completely.

[0031]

Since the positions of the bonding sections 15 in the longitudinal direction never coincide completely and are shifted from each other as above, any parts of the optical fiber ribbons 3a, 3b, 3c, 3d, and 3e are never restrained completely.

[0032]

For example, if the positions of the bonding sections 15 of the adjacent optical fiber ribbons coincide completely by chance, stress may be concentrated on this part when bending transformation or the like is applied to the optical fiber cable 1. On the other hand, if the positions of the bonding sections 15 are shifted only slightly, this shifting, as a trigger, may lead to change the arrangement of the optical fiber ribbons and the like.

[0033]

Here, the length of the bonding section 15 of the optical fiber ribbons 3a, 3b, 3c, 3d, and 3e in the longitudinal direction is L (mm). Also, the distance between the two bonding sections 15 in the longitudinal direction is D (mm). That is, in the optical fiber ribbons 3a, 3b, 3c, 3d, and 3e, all the optical fiber strands 13 are bonded to each other with the same D and L.

[0034]

In addition, one of the optical fiber ribbons is appointed to be a standard optical fiber ribbon. In the example shown in FIG. 3, the optical fiber ribbons 3a is the standard optical fiber ribbon. Also, an end position (in the drawing, the end part on the left side is the end position) of any of the bonding sections 15 of the standard optical fiber ribbon is appointed to be a standard bonding-section position (C in the drawing).

[0035]

In this case, B is a distance between the furthest positions (the foremost end and the rearmost end) among the end positions of the bonding sections 15 of the optical fiber ribbons 3a, 3b, 3c, 3d, and 3e, which are closest to the standard bonding-section position C. There may be a case in which the standard bonding-section position C is the foremost or the rearmost end.

[0036]

In this case, if the maximum shifting amount B is small, the effect of shifting the positions of the bonding sections 15 of the optical fiber ribbons 3a, 3b, 3c, 3d,

and 3e is small. For example, in the example shown in FIG. 3, the maximum shifting amount B is less than half the length L of the bonding section 15, and thus the effect on suppressing stress concentration is small.

[0037]

FIG. 4 is similar to FIG. 3, showing a state in which the shifting amount of the bonding sections 15 is varied. In the example shown in FIG. 4, the maximum shifting amount B is more than half the length L of the bonding section 15.

[0038]

When the maximum shifting amount B is greater than half the length L of the bonding section 15, the effect on suppressing stress concentration is large. For example, the more of the bonding sections overlap, the more likely the increase in transmission loss or the like may occur, which is the problem to be solved by the present invention. Thus, if at least some of the bonding sections 15 of the optical fiber ribbons are shifted with half the length or more in the longitudinal direction, the interference between at least these bonding sections 15 of the optical fiber ribbons can be suppressed.

[0039]

Further preferably, the shifting amount between all the optical fiber ribbons are greater than or equal to half the length L of the bonding section 15. In this way, all of the bonding sections 15 of the optical fiber ribbons do not overlap for more than the half of the length of the bonding section 15, and thus the effect on reducing the transmission loss is large.

[0040]

In this case, a relationship:

$(n - 1) \times L / 2 \leq (D - L) / 2$

is to be satisfied, where n is the number of the optical fiber ribbons to be accommodated. That is, it is required to satisfy a relationship: $nL \leq D$.

[0041]

FIG. 5 is similar to FIG. 3 (however, only the optical fiber ribbons 3a and 3b are shown for simplification), showing a state in which the shifting amount of the bonding sections 15 is further varied. In the example shown in FIG. 5, the bonding sections 15 do not overlap with each other at all. That is, the maximum shifting amount B is greater than or equal to the length L of the bonding section 15.

[0042]

As above, when the bonding sections between at least a pair of the optical fiber ribbons do not overlap with each other at all, the effect on reducing the

transmission loss is large.

[0043]

Furthermore, it is preferable that the bonding sections between not just a pair but a plurality of pairs of the optical fiber ribbons do not overlap with each other at all. And further preferably, all the bonding sections do not overlap with each other at all.

[0044]

In this case, a relationship:

$(n - 1) \times L \leq (D - L) / 2$

is to be satisfied, where n is the number of the optical fiber ribbons to be accommodated. That is, it is required to satisfy a relationship: $(2n - 1) L \leq D$.

[0045]

As above, in the present invention, when a plurality of the optical fiber ribbons are accommodated, the positions of the bonding sections 15 thereof do not coincide completely in the longitudinal direction. Thus, the restraining force on the optical fiber strands 13 forming each of the optical fiber ribbons is weak, which suppresses the application of stress from being concentrated at one place.

[0046]

In addition, if the maximum shifting amount B is greater than or equal to half the length L of the bonding section, the restraint on the optical fiber strands 13 forming each of the optical fiber ribbons can be further suppressed.

[0047]

Furthermore, by making sure that the positions of the bonding sections 15 of at least one pair of the optical fiber ribbons do not overlap with each other in the longitudinal direction, the interference between the bonding sections 15 can be suppressed and the restraint on the optical fiber strands 13 can be further suppressed.

[0048]

Although the embodiments of the present invention have been described referring to the attached drawings, the technical scope of the present invention is not limited to the embodiments described above. It is obvious that persons skilled in the art can think out various examples of changes or modifications within the scope of the technical idea disclosed in the claims, and it will be understood that they naturally belong to the technical scope of the present invention.

DESCRIPTION OF NOTATIONS

[0049]

1 ..... optical fiber cable

3, 3a, 3b, 3c, 3d, 3e ..... optical fiber ribbon

5 ..... buffer layer

7 ..... coat layer

9 ..... tension member

11 ..... ripcord

13 ..... optical fiber strand

15 ..... bonding section

WHAT IS CLAIMED IS

1. An optical fiber cable comprising:

a plurality of optical fiber ribbons which are to be accommodated in the optical fiber cable; and

a coat layer that protects a plurality of the optical fiber ribbons, wherein:

each of the optical fiber ribbons is formed such that a plurality of optical fiber strands are arranged in parallel and integrated;

adjacent optical fiber strands are bonded intermittently with each other along the longitudinal direction of the optical fiber strands; and

positions, in the longitudinal direction, of corresponding bonding sections in adjacent optical fiber ribbons, are shifted with respect to each other.

2. The optical fiber cable according to claim 1, wherein

an end position of any one of bonding sections of a standard optical fiber ribbon, which is arbitrarily selected from a plurality of the optical fiber ribbons, is called as a standard bonding-section position and, for each of the other optical fiber ribbons, the end position of a bonding section that is closest to the standard bonding-section position in the longitudinal direction of the optical fiber cable is called as a bonding-section position respectively; and

each shifting amount between two bonding-section positions, including the standard bonding-section position and all the respective bonding-section positions, is greater than or equal to half the length of the bonding section in the longitudinal direction of the optical fiber cable.

3. The optical fiber cable according to claim**1**, wherein

the positions of the bonding sections of at least one pair of the optical fiber ribbons do not overlap with each other in the longitudinal direction of the optical fiber.