(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 854 920 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
28.07.2021 Bulletin 2021/30

(21) Application number: **19900140.5**

(22) Date of filing: **18.12.2019**

(51) Int Cl.:
D03D 9/00 *(2006.01)* ***A63B 71/02*** *(2006.01)*
D03D 13/00 *(2006.01)* ***D03D 1/00*** *(2006.01)*

(86) International application number:
PCT/KR2019/018036

(87) International publication number:
WO 2020/130647 (25.06.2020 Gazette 2020/26)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **19.12.2018 KR 20180164710**
17.12.2019 KR 20190169125

(71) Applicant: **Kolon Industries, Inc.**
Seoul 07793 (KR)

(72) Inventor: **KIM, Sang Hwan**
Seoul 07793 (KR)

(74) Representative: **Ter Meer Steinmeister & Partner Patentanwälte mbB**
Nymphenburger Straße 4
80335 München (DE)

(54) PROTECTIVE NET FOR SPORTS , AND GOLF PROTECTIVE NET, SOCCER PROTECTIVE NET, BASEBALL PROTECTIVE NET, TENNIS PROTECTIVE NET, AND VOLLEYBALL PROTECTIVE NET USING SAME

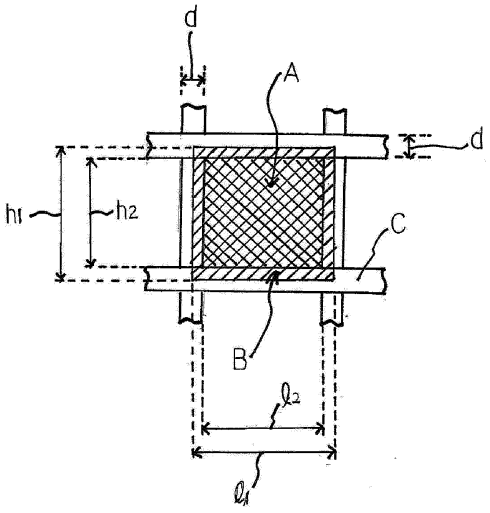
(57) The present invention forms meshes between intersections of synthetic fiber cords while the synthetic fiber cords having a form in which a plurality of synthetic fiber filaments are plied and twisted is crossed in a knotless type, wherein a diameter (d) of the synthetic fiber cord satisfies the Equation (I), a maximum distance (D1) between the intersections adjacent to each other satisfies the Equation (II), and a minimum distance (D2) between the intersections adjacent to each other satisfies the Equation (III).

Since the present invention is made lightweight with a lower areal density than a conventional protective net for sports and increases rate of hole size with a small diameter of the synthetic fiber cord constituting the protective net, the present invention improves resistance against wind during manufacture of a protective net structure, and has excellent mechanical properties and thus provides excellent resistance against impact applied when a ball flies and bumps. Consequently, the present invention minimizes damage and extends a replacement cycle.

Further, the present invention improves visibility with the high rate of hole size, and also improves stability by effectively preventing penetration of the ball between the meshes.

Further, the present invention is easily mounted in the protective net structure and provides excellent flame retardancy and weather resistance.

【FIG. 3】



EP 3 854 920 A1

Description

[TECHNICAL FIELD]

[0001] The present invention relates to a protective net for sports that is installed in golf courses, a baseball field, or the like to prevent a hit golf ball or baseball from escaping out of the protective net, and to a protective net for golf, a protective net for soccer, a protective net for baseball, a protective net for tennis, and a protective net for volleyball using the same. More particularly, the present invention relates to a protective net for sports which is made lightweight, has excellent resistance against wind, provides excellent impact resistance, extends a replacement cycle, has excellent visibility with a high rate of hole size, effectively prevents a golf ball, a baseball, or the like from penetrating out of the protective net, and has an improved stability, excellent flame retardancy and weather resistance, and to a protective net for golf, a protective net for soccer, a protective net for baseball, a protective net for tennis, and a protective net for volleyball using the same.

[BACKGROUND ART]

[0002] Protective nets for sports are installed in a golf course or baseball field and are used to prevent hit golf balls or baseballs, etc. from escaping out of the protective nets.

[0003] As a conventional protective net for sports, a protective net for sports which forms meshes between intersections of high-density polyethylene (hereinafter, referred to as "HDPE") cords while the HDPE cords having a form in which a plurality HDPE filaments are plied and twisted are crossed in a knot type or a knotless type, is mainly used.

[0004] However, the conventional protective net for sports had to set a diameter of the HDPE cords to be thicker than at least 1.8 mm in order to achieve a desired level of impact resistance and abrasion resistance, whereby the protective net for sports has a high areal density and a weakness of windage resistance, so that there were problems that it is easily damaged by the wind after being installed, and a lot of time and manpower are required to remove the protective net.

[0005] Further, the conventional protective net for sports is easily damaged because of having low resistance to impact applied when the hit golf ball flies and bumps against the protective net, and has a low rate of hole size, which is calculated by dividing the area A of FIG. 3 by the area B of FIG. 3 and then multiplying it by 100, and thus, there is a problem that the visibility is also deteriorated.

[0006] In addition, the conventional protective net for sports has a problem that flame retardancy and weather resistance are deteriorated.

[DETAILED DESCRIPTION OF THE INVENTION]

[Technical Problem]

[0007] An object of the present invention is to provide a protective net for sports which is made lightweight, has excellent resistance against wind, provides excellent impact resistance, extends a replacement cycle, has excellent visibility with a high rate of hole size, effectively prevents a golf ball, a baseball, or the like from penetrating out of the protective net, and thus has an improved stability, excellent flame retardancy and weather resistance, and a protective net for golf, a protective net for soccer, a protective net for baseball, a protective net for tennis, and a protective net for volleyball using the same.

[Technical Solution]

[0008] In order to achieve the above object, there is provided a protective net for sports which forms meshes between intersections of synthetic fiber cords while the synthetic fiber cords having a form in which a plurality of synthetic fiber filaments are plied and twisted are crossed in a knotless type, wherein a diameter (d) of the synthetic fiber cord satisfies the following Equation (I), a maximum distance (D1) between the intersections adjacent to each other satisfies the following Equation (II), and a minimum distance (D2) between the intersections adjacent to each other satisfies the following Equation (III):

$$\text{Diameter (d) of synthetic fiber cord} = N \times \sqrt{\frac{m \times \sin^2(\theta) \times \frac{1}{2}(v_0^2 - 9.81 \times h)}{\sigma \times \varepsilon \times L \times \pi}} \quad \cdots\cdots (I)$$

$$\text{Maximum distance (D1) between adjacent intersections} = \frac{\pi R}{2(1+\varepsilon)} \quad \cdots\cdots (II)$$

$$\text{Minimum distance (D2) between adjacent intersections} = \frac{\pi R}{2(1+\varepsilon)} \times \left(\frac{n}{n+4}\right) \quad \cdots\cdots (III)$$

[0009] In the Equations (I), (II) and (III), the units of each of the diameter (d) of the synthetic fiber cord, the maximum distance (D1) and the minimum distance (D2) between intersections adjacent to each other are mm, m is a mass of a ball, N is a constant of 14.14214, ε is an strain of the synthetic fiber filament material, θ is ball hitting angle, σ is a stress of the synthetic fiber filament material, Vo is a maximum velocity of a hit ball, L is a total length of a net bumped by the hit ball, which is calculated by the following Equation (IV), h is a height of the net that receives impact by the hit ball, which is calculated by the following Equation (V), R is a radius of the ball to which hit is applied, and n is the number of twists applied to the synthetic fiber filament to prepare the synthetic fiber cord;

$$L = 12.007 \times N2 \times \sqrt{N1} \quad \text{.....(IV)}$$

[0010] In the above Equation (IV), N2 is an integer of 12, 17 or 24 as the number of distances (D) between the intersections of the net that receives impact by the hit ball, and N1 is an integer of 1,2 or 4 as the number of intersections of the synthetic fiber cords to which the impact is applied by the ball;

$$h = \frac{(Vo \times \sin\theta)^2}{2 \times 9.81} \quad \cdots\cdots (V)$$

in the Equation (V), Vo is an initial velocity of the hit ball, and θ is a ball hitting angle.

[0011] In the Equation (IV), N2 may be obtained by a maximum value and a minimum value of the diameter (d) of the synthetic fiber cord of the Equation (I), based on the number of distances (D) between the intersections of the net that receives impact by the hit ball.

[ADVANTAGEOUS EFFECTS]

[0012] Since the present invention is made lightweight with a lower areal density than a conventional protective net for sports and increases rate of hole size with a small diameter of the synthetic fiber cord constituting the protective net, the present invention improves resistance against wind during manufacture of a protective net structure, and has excellent mechanical properties and thus provides excellent resistance against impact applied when a ball flies and bumps. Consequently, the present invention minimizes damage and extends a replacement cycle.

[0013] Further, the present invention improves visibility with the high rate of hole size, and also improves stability by effectively preventing penetration of the ball between the meshes.

[0014] Further, the present invention is easily mounted in the protective net structure and provides excellent flame retardancy and weather resistance.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0015]

FIG. 1 is a plan view showing a part of a protective net for sports.
FIG. 2 is an enlarged photograph showing an intersection (X) of the synthetic fiber cord (C) in FIG. 1.
FIG. 3 is a schematic diagram showing an area A and an area B used for calculating a rate of hole size.
FIGS. 4 to 6 are schematic diagrams showing the number (N2) of distances (D) between intersections of a protective net that receives impact by a ball according to a position where the ball is bumped against the protective net.

[DETAILED DESCRIPTION OF THE EMBODIMENTS]

[0016] Hereinafter, the present invention will be described in detail through the accompanying drawings.

[0017] As shown in FIGS. 1 and 2, the protective net for sports according to the present invention is characterized by

forming meshes between intersections of synthetic fiber cords while the synthetic fiber cords in which a plurality of synthetic fiber filaments are plied and twisted are crossed in a knotless type, wherein a diameter (d) of the synthetic fiber cord satisfies the following Equation (I), a maximum distance (D1) between the intersections adjacent to each other satisfies the following Equation (II), and a minimum distance (D2) between the intersections adjacent to each other satisfies the following Equation (III):

$$\text{Diameter (d) of synthetic fiber cord} = N \times \sqrt{\frac{m \times \sin^2(\theta) \times \frac{1}{2}(v_0^2 - 9.81 \times h)}{\sigma \times \varepsilon \times L \times \pi}} \quad \cdots\cdots (I)$$

$$\text{Maximum distance (D1) between adjacent intersections} = \frac{\pi R}{2(1+\varepsilon)} \quad \cdots\cdots (II)$$

$$\text{Minimum distance (D2) between adjacent intersections} = \frac{\pi R}{2(1+\varepsilon)} \times \left(\frac{n}{n+4}\right) \quad \cdots\cdots (III)$$

in the Equations (I), (II) and (III), the units of each of the diameter (d) of the synthetic fiber cord, the maximum distance (D1) and the minimum distance (D2) between the intersections adjacent to each other are mm, m is a mass of a ball, N is a constant of 14.14214, ε is an strain of the synthetic fiber filament material, θ is ball hitting angle, σ is a stress of the synthetic fiber filament material, Vo is a maximum velocity of a hit ball, L is a total length of a net bumped by the hit ball, which is calculated by the following Equation (IV), h is a height of the net that receives impact by the hit ball, which is calculated by the following Equation (V), R is a radius of the ball to which hit is applied, and n is the number of twists applied to the synthetic fiber filament to prepare the synthetic fiber cord,

$$L = 12.007 \times N2 \times \sqrt{N1} \quad \cdots\cdots (IV)$$

[0018] in the Equation (IV), N2 is an integer of 12, 17 or 24 as the number of distances (D) between the intersections of the net that receives impact by the hit ball, and N1 is an integer of 1,2 or 4 as the number of intersections of the synthetic fiber cords to which the impact is applied by the ball,

$$h = \frac{(Vo \times \sin\theta)^2}{2 \times 9.81} \quad \cdots\cdots (V)$$

in the Equation (V), Vo is an initial velocity of the hit ball, and θ is a ball hitting angle.

[0019] The number (N2) of the distances (D) between the intersections which receive impact by the hit ball is determined depending on a position where the ball bumps against the protective net as shown in FIGS. 4 to 6.

[0020] Specifically, when the ball bumps against the position of the protective net shown in FIG. 4, the number (N2) of the distances (D) between the intersections which receive impact by the hit ball becomes 12, and the number (N1) of intersections which receive impact by the hit ball becomes 1.

[0021] On the other hand, when the ball bumps against the position of the protective net shown in FIG. 5, the number (N2) of the distances (D) between the intersections which receive impact by the hit ball becomes 17, and the number (N1) of intersections which receive impact by the hit ball becomes 2.

[0022] On the other hand, when the ball bumps against the position of the protective net shown in FIG. 6, the number (N2) of the distances (D) between the intersections becomes 24, and the number (N1) of intersections which receive impact by the hit ball becomes 4.

[0023] The protective net for sports of the present invention may be used as a protective net for golf, a protective net for soccer, a protective net for baseball, a protective net for tennis, a protective net for volleyball, or the like.

[0024] As the synthetic fiber filament constituting the synthetic fiber cord, an aramid filament may be used alone, or the aramid filament and other synthetic fiber filament except the aramid filament may be used in a combination with each other.

[0025] If the present invention uses the protective net for golf in which the synthetic fiber cord is an aramid cord consisting of the aramid filament, it is preferred that a diameter (d) of the aramid cord is 0.85 mm to 1.5 mm, a maximum

distance (D1) of the intersections adjacent to each other is 35 mm or less, and a minimum distance (D2) of the intersections adjacent to each other is 20 mm or more.

[0026] If the present invention uses the protective net for soccer in which the synthetic fiber cord is an aramid cord consisting of the aramid filament, it is preferred that a diameter (d) of the aramid cord is 0.59 mm to 0.84 mm, a maximum distance (D1) of the intersections adjacent to each other is 140 mm or less, and a minimum distance (D2) of the intersections adjacent to each other is 130 mm or more.

[0027] If the present invention uses the protective net for baseball in which the synthetic fiber cord is an aramid cord consisting of the aramid filament, it is preferred that a diameter (d) of the aramid cord is 0.75 mm to 1.07 mm, a maximum distance (D1) of the intersections adjacent to each other is 50 mm or less, and a minimum distance (D2) of the intersections adjacent to each other is 40 mm or more.

[0028] If the present invention uses the synthetic fiber cord as the protective net for tennis, it is preferred that a diameter (d) of the synthetic fiber cord is 0.73 mm to 1.03 mm, a maximum distance (D1) of the intersections adjacent to each other is 42 mm or less, and a minimum distance (D2) of the intersections adjacent to each other is 38 mm or more.

[0029] If the present invention uses the synthetic fiber cord as the protective net for volleyball, it is preferred that a diameter (d) of the synthetic fiber cord is 0.33 mm to 0.47 mm, a maximum distance (D1) of the intersections adjacent to each other is 126 mm or less, and a minimum distance (D2) of the intersections adjacent to each other is 122 mm or more.

[0030] When the diameter (d) of the synthetic fiber cord is lower than the above range, the mechanical properties such as a tensile strength and an abrasion resistance of the synthetic fiber cord are deteriorated, and thus, there is highly likely that the protective net for sports is easily damaged by an impact applied when the hit golf ball or baseball ball flies and bumps against the protective net, whereas when the diameter (d) of the synthetic fiber cord exceeds the above range, since a areal density of the protective net for sports becomes heavier than 180 g/m^2 and the dimeter of the protective net diameter increases, a resistance to external environments such as wind and typhoons is reduced, which increases a likelihood that the installed protective net is easily damaged, and a rate of hole size of the protective net for sports is lowered to less than 88%, making viewing of the game uncomfortable.

[0031] If the distance between the intersections (X) of the synthetic fiber cords exceeds the above range, there is a problem that a protective function of the protective net for sports is deteriorated due to penetration of a golf ball or a baseball through a mesh of the protective net for sports. If it is less than the above range, the mesh is formed too small, making viewing of the game uncomfortable.

[0032] That is, the protective net for sports according to the present invention wherein the diameter (d) of the synthetic fiber cord is 0.85 mm to 1.5 mm, the maximum distance (D1) of the intersections adjacent to each other is 35 mm or less, and the minimum distance (D2) of the intersections adjacent to each other is 20 mm or more, can be used as the protective net for golf.

[0033] Further, the protective net for sports according to the present invention wherein the diameter (d) of the synthetic fiber cord is 0.59 mm to 0.84 mm, the maximum distance (D1) of the intersections adjacent to each other is 140 mm or less, and the minimum distance (D2) of the intersections adjacent to each other is 135 mm or more can be used as the protective net for soccer.

[0034] Further, the protective net for sports according to the present invention wherein the diameter (d) of the synthetic fiber cord is 0.75 mm to 1.07 mm, the maximum distance (D1) of the intersections adjacent to each other is 50 mm or less, and the minimum distance (D2) of the intersections adjacent to each other is 40 mm or more can be used the protective net for baseball.

[0035] Further, the protective net for sports according to the present invention wherein the diameter (d) of the synthetic fiber cord is 0.73 mm to 1.03 mm, the maximum distance (D1) of the intersections adjacent to each other is 42 mm or less, and the minimum distance (D2) of the intersections adjacent to each other is 38 mm or more can be used as the protective net for tennis.

[0036] Further, the protective net for sports according to the present invention wherein the diameter (d) of the synthetic fiber cord is 0.33 mm to 0.47 mm, the maximum distance (D1) of the intersections adjacent to each other is 126 mm or less, and the minimum distance (D2) of the intersections adjacent to each other is 122 mm or more can be used as the protective net for volleyball.

[0037] The aramid cord (C) consists of two strands and three or less strands of aramid filaments having a fineness of preferably 1,200 denier to 5,000 denier, more preferably 2,000 to 5,000 denier, and an strain of the aramid filament is preferably 2 % or more and 4 % or less.

[0038] Those in which a resin containing an ultraviolet stabilizer is coated onto the synthetic fiber cord are more preferable for improving a weather resistance.

[0039] The protective net for sports of the present invention has a cutting strength of 114 daN or more, or 114 daN to 120 daN, and may be configured to sew a fabric having a narrow width at an end of the protective net for sports to improve mounting during installation.

[0040] As one embodiment, in order to prevent all loosening of the protective net of a Knotless type when cutting or installing the protective net, a fine fabric is sewn at the end of the protective net.

[0041] As another embodiment, in order to easily hang or mount the protective net on a post for installation of the protective net, a metal ring-typed jig may be installed when sewing the fine fabric at the end of the protective net.

[0042] As still another embodiment, when Velcro is attached to the post for installation of the protective net, in order to improve attachability and detachability of the protective net, the Velcro may be sewn together when stitching the fine fabric at the end of the protective net.

[0043] The present invention is made lightweight with a lower areal density than a conventional protective net for sports, and a diameter of the synthetic fiber cord constituting the protective net is considerably smaller than a diameter of the conventional HDPE cord which leads to an increase in a rate of hole size. Therefore, the present invention improves resistance against wind during manufacture of a protective net structure, and has excellent mechanical properties and thus provides excellent resistance against impact applied when a golf ball or a baseball ball flies and bumps. Consequently, the present invention minimizes damage and extends a replacement cycle.

[0044] Specifically, the rate of hole size of the protective net for sports may be 90 % or more, 90 % to 100 %, or 90 % to 99.5 %, according to the following Equation (VI):

$$\text{Rate of hole size} = \left(\frac{A}{B}\right) \times 100 \quad \cdots\cdots\cdots (VI)$$

in the Equation (VI), A is an area of the mesh, and B is an area obtained by multiplying a value ($\ell 1$) adding a diameter (d) of the aramid cord to a transverse length ($\ell 2$) of the mesh, and a value (h1) adding the diameter (d) of the aramid cord to a longitudinal length (h2) of the mesh.

[0045] Further, an abrasion resistance may be 20 minutes or more, or 20 minutes to 35 minutes, wherein the abrasion resistance is a time required to damage the protective net by allowing a golf ball rotating at 3,000 rpm to contact the same position of the protective net after mounting the protective net to a rotational friction tester.

[0046] Further, a areal density of the protective net for sports may be 1 g/m^2 to 100 g/m^2, or 5 g/m^2 to 80 g/m^2.

[0047] Furthermore, the protective net for sports of the present invention also can improve a stability by effectively preventing a golf ball or a baseball ball from penetrating between the meshes, while enhancing a visibility due to the high rate of hole size.

[0048] Still furthermore, the protective net for sports of the present invention can be easily mounted on a structure of the protective net, and has an excellent flame retardancy and a weather resistance.

[0049] Hereinafter, the present invention will be described in more detail by way of examples and comparative examples.

[0050] However, the protection scope of the present invention should not be interpreted as being limited only to these examples.

Example 1

[0051] Two strands of aramid filaments having an strain of 3 % and a fineness of 4,500 denier were plied and twisted to prepare aramid cords having a diameter (d) of 0.95 mm.

[0052] Next, meshes were formed while crossing the aramid cords in a knotless type as shown in FIGS. 1 and 2, thereby manufacturing a protective net for golf.

[0053] In this case, an distance between the intersections (X) of the aramid cords was adjusted to 25 mm.

[0054] The results of evaluating a cutting strength, a areal density, a rate of hole size, and an abrasion resistance of the manufactured protective net for golf were shown in Table 1.

Comparative Example 1

[0055] Two strands of aramid filaments having a fineness of 3,000 denier were plied and twisted to prepare aramid cords having a diameter (d) of 0.8 mm.

[0056] Next, meshes were formed while crossing the aramid cords in a knotless type as shown in FIGS. 1 and 2 to manufacture a protective net for golf.

[0057] In this case, an distance between the intersections (X) of the aramid cords was adjusted to 23 mm.

Comparative Example 2

[0058] Five strands of high-density polyethylene (HDPE) filaments having a fineness of 3,000 denier were plied and

twisted to prepare HDPE cords having a diameter (d) of 1.40 mm.

[0059] Next, meshes were formed while crossing the HDPE cords in a knotless type as shown in FIGS. 1 and 2 to manufacture a protective net for golf.

[0060] In this case, an distance between the intersections (X) of the HDPE chodes was adjusted to 23 mm.

[0061] The results of evaluating a cutting strength, a areal density, a rate of hole size, and an abrasion resistance of the manufactured protective net for golf were shown in Table 1.

[Table 1]

Category		Example 1	Comparative Example 1	Comparative Example 2
Equation(I)	Maximum value	1.06 mm	1.03 mm	1.94 mm
	Minimum value	0.95 mm	0.92 mm	1.72 mm
Equation(II)		32.42 mm	32.42 mm	29.64 mm
Equation(III)		25.01 mm	25.01 mm	22.86 mm
Cutting strength(daN)		114	113	71
Rate of hole size(%)		92.2	94.5	86.1
Areal density(g/m^2)		66	52	120
Abrasion resistance(hour)		31 (Unbroken)	17	17

[0062] In Table 1 above, the values of Equation (I), Equation (II) and Equation (III) are as follows.

$$\text{Diameter (d) of synthetic fiber cord} = N \times \sqrt{\frac{m \times \sin^2(\theta) \times \frac{1}{2}(v_0^2 - 9.81 \times h)}{\sigma \times \varepsilon \times L \times \pi}} \quad \cdots\cdots (I)$$

$$\text{Maximum distance (D1) between adjacent intersections} = \frac{\pi R}{2(1+\varepsilon)} \quad \cdots\cdots (II)$$

$$\text{Minimum distance (D2) between adjacent intersections} = \frac{\pi R}{2(1+\varepsilon)} \times \left(\frac{n}{n+4}\right) \quad \cdots\cdots (III)$$

[0063] In the Equations (I), (II) and (III), the units of each of the diameter (d) of the synthetic fiber cord, the maximum distance (D1) and the minimum distance (D2) between the intersections adjacent to each other are mm, m is a mass of a ball, N is a constant of 14.14214, ε is an strain of the synthetic fiber filament material, θ is a ball hitting angle, σ is a stress of the synthetic fiber filament material, Vo is a maximum velocity of a hit ball, L is a total length of a net that receives impact by the hit ball, which is calculated by the following Equation (IV), h is a height of the net that receives impact by the hit ball, which is calculated by the following Equation (V), R is a radius of the ball to which hit is applied, and n is the number of twists applied to the synthetic fiber filament to prepare the synthetic fiber cord,

$$L = 12.007 \times N2 \times \sqrt{N1} \quad \text{.....(IV)}$$

in the Equation (IV), N2 is an integer of 12, 17 or 24 as the number of distances (D) between the intersections of the net that receives impact by the hit ball, and N1 is an integer of 1,2 or 4 as the number of intersections of the synthetic fiber cords to which the impact is applied by the ball;

$$h = \frac{(Vo \times \sin\theta)^2}{2 \times 9.81} \quad \cdots\cdots (V)$$

in the Equation (V), Vo is an initial velocity of the hit ball, and θ is a ball hitting angle.

[0064] As shown in Table 1 above, it could be confirmed that, unlike the protective net for golf manufactured in Example 1, the protective net for golf manufactured in Comparative Example 1 where the distances between the intersections (X) does not fall within the ranges of Equations (II) and (III) had remarkably poor abrasion resistance of the protective net.

[0065] Further, it could be confirmed that, unlike the protective net for golf manufactured in Example 1, the protective net for golf manufactured in Comparative Example 2 where the cord diameter did not satisfy Equation (I) and the cord material was changed to the HDPE had remarkably poor abrasion resistance and cutting strength.

Example 2

[0066] Two strands of aramid filaments having a fineness of 3,000 denier were plied and twisted to prepare aramid cords having a diameter of 0.7 mm.

[0067] Next, meshes were formed while crossing the aramid cords in a knotless type as shown in FIGS. 1 and 2 to manufacture a protective net for soccer.

[0068] In this case, an distance between the intersections (X) of the aramid cords was adjusted to 137 mm.

[0069] The results of evaluating a cutting strength, a areal density, a rate of hole size, and an abrasion resistance of the manufactured protective net for soccer were shown in Table 2.

Example 3

[0070] Two strands of aramid filaments having a fineness of 3,000 denier were Plied and twisted to prepare aramid cords having a diameter of 0.9 mm.

[0071] Next, meshes were formed while crossing the aramid cords in a knotless type as shown in FIGS. 1 and 2 to manufacture a protective net for baseball.

[0072] In this case, an distance between the intersections (X) of the aramid cords was adjusted to 45 mm.

[0073] The results of evaluating a cutting strength, a areal density, a rate of hole size, and an abrasion resistance of the manufactured protective net for baseball were shown in Table 2.

Example 4

[0074] Two strands of aramid filaments having a fineness of 3,000 denier were plied and twisted to prepare aramid cords having a diameter of 0.85 mm.

[0075] Next, meshes were formed while crossing the aramid cords in a knotless type as shown in FIGS. 1 and 2 to manufacture a protective net for tennis.

[0076] In this case, an distance between the intersections (X) of the aramid cords was adjusted to 40 mm.

[0077] The results of evaluating a cutting strength, a areal density, a rate of hole size, and an abrasion resistance of the manufactured protective net for tennis were shown in Table 2.

Example 5

[0078] Two strands of aramid filaments having a fineness of 3,000 denier were Plied and twisted to prepare aramid cords having a diameter of 0.4 mm.

[0079] Next, meshes were formed while crossing the aramid cords in a knotless type as shown in FIGS. 1 and 2 to manufacture a protective net for volleyball.

[0080] In this case, an distance between the intersections (X) of the aramid cords was adjusted to 124 mm.

[0081] The results of evaluating a cutting strength, a areal density, a rate of hole size, and an abrasion resistance of the manufactured protective net for soccer were shown in Table 2.

[Table 2]

Category		Example 2	Example 3	Example 4	Example 5
Equation(I)	Maximum value	0.84 mm	1.07 mm	1.03 mm	0.47 mm
	Minimum value	0.59 mm	0.75 mm	0.73 mm	0.33 mm
Equation(II)		167.18 mm	54.96 mm	48.26 mm	151.98 mm
Equation(III)		128.97 mm	34.96 mm	30.71 mm	96.72 mm
Cutting strength(daN)		114	114	114	114

(continued)

Category	Example 2	Example 3	Example 4	Example 5
Rate of hole size(%)	99.0	96.0	95.8	99.3
Areal density(g/m^2)	10	47	46	6
Abrasion resistance(hour)	31 (Unbroken)	31 (Unbroken)	31 (Unbroken)	31 (Unbroken)

[0082] The physical properties of Table 1 and Table 2 were evaluated by the following method:

Cutting strength (daN)

[0083] The cutting strength was measured by collecting the mesh and fixing both ends thereof according to KS K ISO 1806, which is a mesh cutting load measurement method of a fishing net.

Rate of hole size (%)

[0084] As shown in FIG. 3, the rate of hole size was calculated by substituting (i) an area (A) of the mesh and (ii) an area (B) into the following Equation (VI), wherein the area (B) was obtained by multiplying a value (ℓ1) adding a diameter (d) of the aramid cord to a transverse length (ℓ2) of the mesh, and a value (h1) adding the diameter (d) of the aramid cord to a longitudinal length (h2) of the mesh:

$$\text{Rate of hole size} = \left(\frac{A}{B}\right) \times 100 \quad \cdots\cdots\cdots \quad (VI)$$

[0085] Areal density (g/m^2)

[0086] The areal density was obtained by measuring a weight of the protective net with 1m wide $\times$ 1m long.

Abrasion resistance (hours)

[0087] The abrasion resistance was expressed as a time required to damage the protective net by allowing a golf ball rotating at 3,000 rpm to contact the same position of the protective net after mounting the protective net to a rotational friction tester.

[Description of Reference Numerals]

[0088]

C: synthetic fiber cord
d: diameter of synthetic fiber cord (C)
X: intersection between synthetic fiber cords (C)
A: area of mesh
h2: longitudinal length of mesh
ℓ2: transverse length of mesh
h1: value adding diameter (d) of aramid cord to longitudinal length (h2) of mesh
ℓ1: Value adding diameter of aramid cord to transverse length (ℓ2) of mesh
B: area multiplying h1 and ℓ1
1: protective net for sports
2: ball
D: distance between intersections (X) of synthetic fiber cords

Claims

1. A protective net for sports **characterized by** forming meshes between intersections of synthetic fiber cords while the synthetic fiber cords having a form in which a plurality of synthetic fiber filaments are plied and twisted are crossed in a knotless type, wherein a diameter (d) of the synthetic fiber cord satisfies the following Equation (I), a maximum distance (D1) between the intersections adjacent to each other satisfies the following Equation (II), and a minimum distance (D2) between the intersections adjacent to each other satisfies the following Equation (III):

$$\text{Diameter (d) of synthetic fiber cord} = N \times \sqrt{\frac{m \times \sin^2(\theta) \times \frac{1}{2}(v_0^2 - 9.81 \times h)}{\sigma \times \varepsilon \times L \times \pi}} \quad \cdots\cdots (I)$$

$$\text{Maximum distance (D1) between adjacent intersections} = \frac{\pi R}{2(1+\varepsilon)} \quad \cdots\cdots (II)$$

$$\text{Minimum distance (D2) between adjacent intersections} = \frac{\pi R}{2(1+\varepsilon)} \times \left(\frac{n}{n+4}\right) \quad \cdots\cdots (III)$$

in the Equations (I), (II) and (III), the units of each of a diameter (d) of the synthetic fiber cord, a maximum distance (D1) and a minimum distance (D2) between the intersections adjacent to each other are mm, m is a mass of a ball, N is a constant of 14.14214, ε is an strain of the synthetic fiber filament material, θ is ball hitting angle, σ is a stress of the synthetic fiber filament material, Vo is a maximum velocity of a hit ball, L is a total length of the net that receives impact by the hit ball, which is calculated by the following Equation (IV), h is a height of the net that receives impact by the hit ball, which is calculated by the following Equation (V), R is a radius of the ball to which hit is applied, and n is the number of twists applied to the synthetic fiber filament to prepare the synthetic fiber cord,

$$L = 12.007 \times N2 \times \sqrt{\quad N1 \quad} \quad \text{.....(IV)}$$

in the Equation (IV), N2 is an integer of 12, 17 or 24 as the number of distances (D) between the intersections of the net that receives impact by the hit ball, and N1 is an integer of 1,2 or 4 as the number of intersections of the synthetic fiber cords to which the impact is applied by the ball;

$$h = \frac{(Vo \times \sin\theta)^2}{2 \times 9.81} \quad \cdots\cdots (V)$$

in the Equation (V), Vo is an initial velocity of the hit ball, and θ is a ball hitting angle.

2. The protective net for sports according to claim 1, wherein the synthetic fiber filament is an aramid filament.

3. The protective net for sports according to claim 1, wherein the synthetic fiber cord includes an aramid filament.

4. The protective net for sports according to claim 2, wherein the aramid filament has an strain of 2 % to 4 % or less.

5. The protective net for sports according to claim 1, wherein a areal density of the protective net for sports is 1 g/m^2 to 100 g/m^2 or less.

6. The protective net for sports according to claim 1, wherein a resin containing an ultraviolet stabilizer is coated onto the synthetic fiber cord.

7. The protective net for sports according to claim 1, wherein a fabric having a narrow width is sewn to an end of the protective net for sports.

8. The protective net for sports according to claim 1, wherein a cutting strength of the protective net for sports is 114 daN or more.

9. The protective net for sports according to claim 1, wherein a rate of hole size of the protective net for sports is 90 % or more by the following Equation (VI):

$$\text{Rate of hole size} = \left(\frac{A}{B}\right) \times 100 \quad \cdots\cdots\cdots \quad (VI)$$

in the Equation (VI), A is an area of the mesh, and B is an area obtained by multiplying a value ($\ell 1$) adding a diameter (d) of the aramid cord to a transverse length ($\ell 2$) of the mesh, and a value (h1) adding the diameter (d) of the aramid cord to a longitudinal length (h2) of the mesh.

10. The protective net for sports according to claim 1, wherein an abrasion resistance is 20 minutes or more, the abrasion resistance being a time required to damage the protective net by allowing a golf ball rotating at 3,000 rpm to contact the same position of the protective net after mounting the protective net for sports to a rotational friction tester.

11. The protective net for sports according to claim 1, wherein the diameter (d) of the synthetic fiber cord is 0.85 mm to 1.5 mm, the maximum distance (D1) of the intersections adjacent to each other is 35 mm or less, and the minimum distance (D2) of the intersections adjacent to each other is 20 mm or more.

12. The protective net for sports according to claim 1, wherein the diameter (d) of the synthetic fiber cord is 0.59 mm to 0.84 mm, the maximum distance (D1) of the intersections adjacent to each other is 140 mm or less, and the minimum distance (D2) of the intersections adjacent to each other is 135 mm or more.

13. The protective net for sports according to claim 1, wherein the diameter (d) of the synthetic fiber cord is 0.75 mm to 1.07 mm, the maximum distance (D1) of the intersections adjacent to each other is 50 mm or less, and the minimum distance (D2) of the intersections adjacent to each other is 40 mm or more.

14. The protective net for sports according to claim 1, wherein the diameter (d) of the synthetic fiber cord is 0.73 mm to 1.03 mm, the maximum distance (D1) of the intersections adjacent to each other is 42 mm or less, and the minimum distance (D2) of the intersections adjacent to each other is 38 mm or more.

15. The protective net for sports according to claim 1, wherein the diameter (d) of the synthetic fiber cord is 0.33 mm to 0.47 mm, the maximum distance (D1) of the intersections adjacent to each other is 126 mm or less, and the minimum distance (D2) of the intersections adjacent to each other is 122 mm or more.

16. A protective net for golf **characterized by** using the protective net for sports of claim 11.

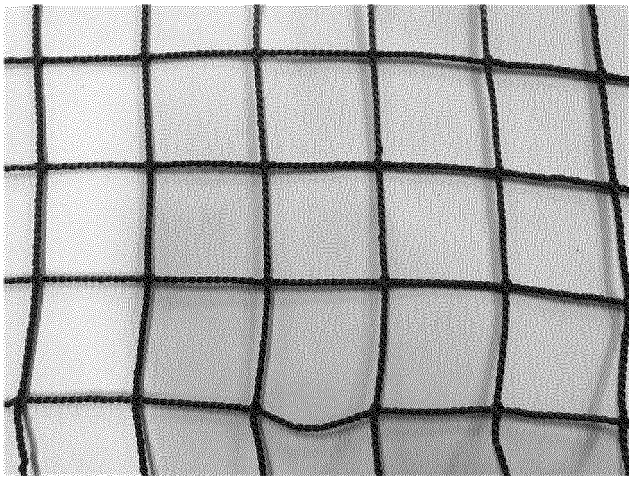
17. A protective net for soccer **characterized by** using the protective net for sports of claim 12.

18. A protective net for baseball **characterized by** using the protective net for sports of claim 13.

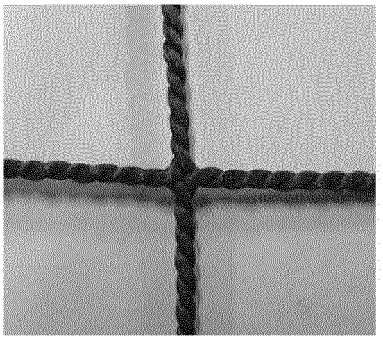
19. A protective net for tennis **characterized by** using the protective net for sports of claim 14.

20. A protective net for volleyball **characterized by** using the protective net for sports of claim 15.

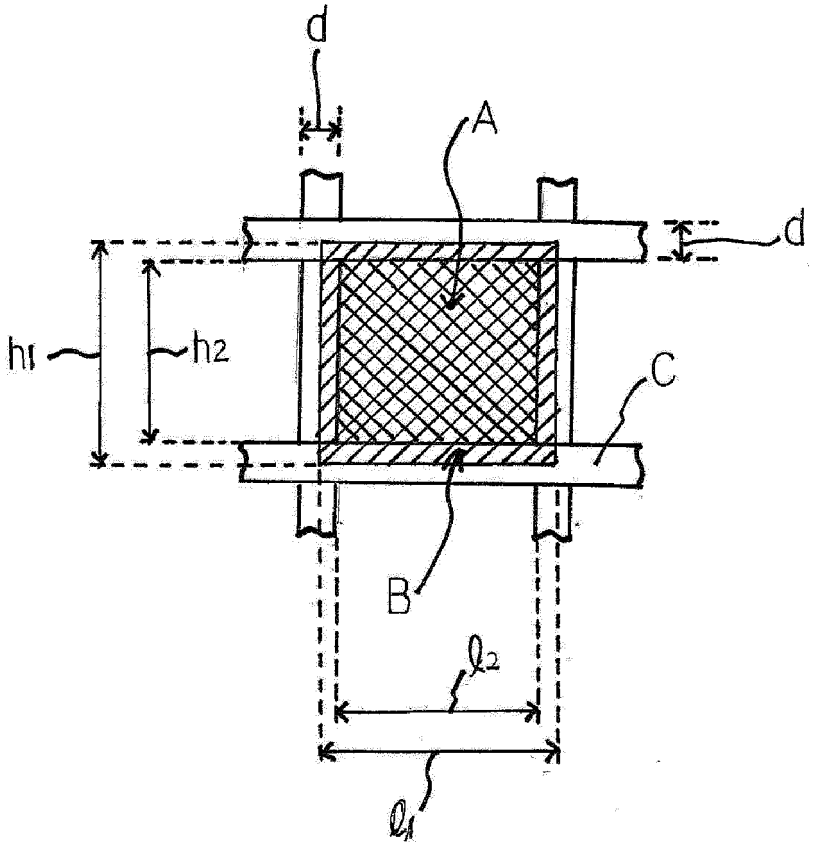
【FIG. 1】



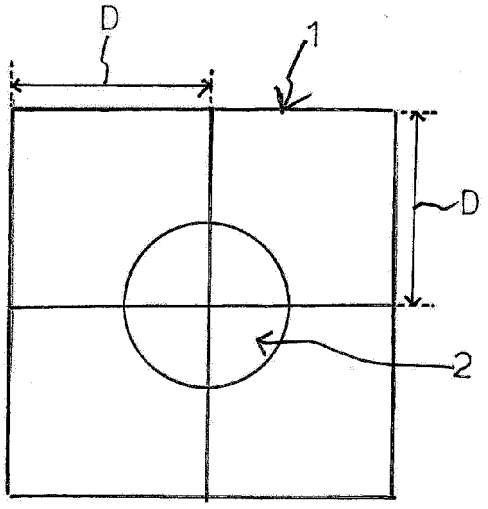
【FIG. 2】



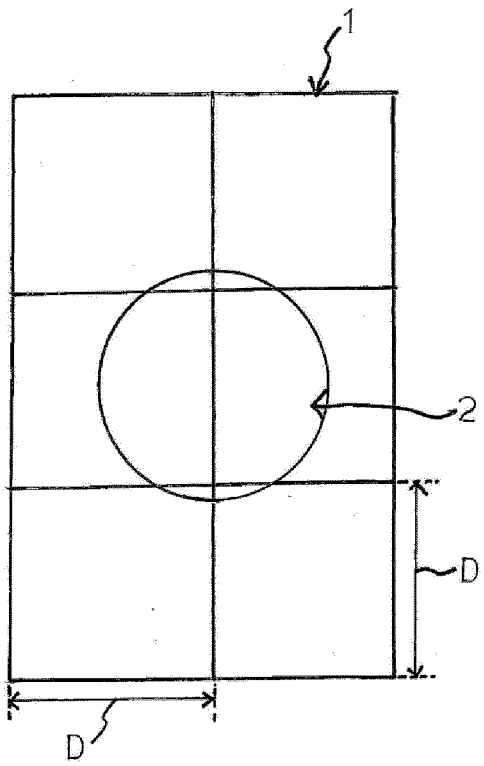
【FIG. 3】



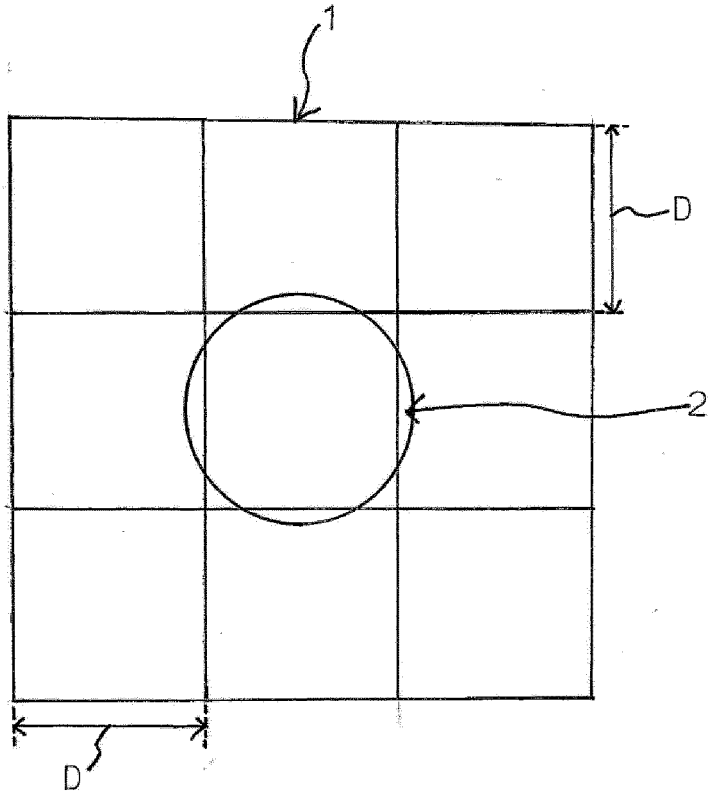
【FIG. 4】



【FIG. 5】



【FIG. 6】



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2019/018036

A. CLASSIFICATION OF SUBJECT MATTER

D03D 9/00(2006.01)i, A63B 71/02(2006.01)i, D03D 13/00(2006.01)i, D03D 1/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

D03D 9/00; A01K 61/00; A63B 69/36; A63B 71/02; D02G 3/44; D03D 1/00; D06M 15/423; D06M 15/564; D06N 3/14; D03D 13/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models: IPC as above
Japanese utility models and applications for utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS (KIPO internal) & Keywords: synthetic fiber chord, knotless type, diameter, interval, protective net for sports

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 10-1594212 B1 (KOLON INDUSTRIES, INC.) 15 February 2016 See claims 1, 5, 9; and figure 1.	1-20
A	KR 20-0322385 Y1 (SEJIN ROPE CO., LTD.) 09 August 2003 See the entire document.	1-20
A	JP 2001-288640 A (MARUHACHI KK.) 19 October 2001 See the entire document.	1-20
A	JP 2009-291597 A (KURARAY CO., LTD. et al.) 17 December 2009 See the entire document.	1-20
A	US 2014-0202393 A1 (ROBERTSON, Kenneth Merrill, Jr. et al.) 24 July 2014 See the entire document.	1-20

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 APRIL 2020 (13.04.2020)	**14 APRIL 2020 (14.04.2020)**

Name and mailing address of the ISA/KR
Korean Intellectual Property Office
Government Complex Daejeon Building 4, 189, Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea
Facsimile No. +82-42-481-8578

Authorized officer

Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2019/018036

Patent document cited in search report	Publication date	Patent family member	Publication date
KR 10-1594212 B1	15/02/2016	KR 10-2014-0080013 A	30/06/2014
KR 20-0322385 Y1	09/08/2003	None	
JP 2001-288640 A	19/10/2001	None	
JP 2009-291597 A	17/12/2009	JP 5498050 B2	21/05/2014
US 2014-0202393 A1	24/07/2014	AU 2012-277803 A1	16/01/2014
		EP 2726656 A1	07/05/2014
		JP 2014-522640 A	08/09/2014
		WO 2013-000995 A1	03/01/2013

Form PCT/ISA/210 (patent family annex) (January 2015)