

NON-METALLIC ARMORED SUBMARINE CABLE

TECHNICAL FIELD

[0001] The present invention relates to the technical field of submarine cables, and in particular to a light non-metallic armored submarine cable.

BACKGROUND

[0002] In recent years, with the rapid development of offshore wind power and offshore power transmission, the demand for submarine cables is increasing. Due to increasing saturation of wind fields in offshore areas and increasing demand for power communication and transmission projects across oceans and waters, submarine cables are gradually developing towards large cross-section, high voltage and great water depth. Existing alternating and direct current submarine cable structures generally adopt an armoring type of metal wire, such as a steel wire, a copper wire, and has high tensile strength and elastic modulus. However, for a high pressure submarine cable structure, the weight of the metallic armoring layer can generally account for 30-50% of the total weight of the submarine cable. Under a condition that the water depth exceeds 500 m, the submarine cable will be subjected to a great underwater tension after being laid from a ship to hundreds of meters underwater, and the influence of its own weight is obvious. At the same time, the submarine cable will also be clamped by a wire-releasing system during a wire-releasing, and a large weight of the submarine cable will increase the squeezing force of the wire-releasing system, which is not beneficial to construction and installation of the submarine cable. Therefore, at present, the application of the high pressure submarine cable with a water depth above 1000 m is very rare at home and abroad, and a deep-sea environment poses a higher challenge to armoring materials and structural types of the submarine cable.

[0003] For a great water depth submarine cable, in order to ensure the mechanical performance of the submarine cable, the existing armoring type usually adopts a multi-layer reverse metal wire twisting type. If the metallic armored structure continues to be used, this will not only increase the weight of the submarine cable, but also be subjected to greater ocean

currents and tidal actions during laying and operation of the submarine cable, which will cause greater bending under the action of a great water depth, and the multi-layer armoring metal wire will easily cause a great elastic stress, resulting in a "lantern" bulging phenomenon. If a non-metallic armor type with a lower density is adopted, the strength of the non-metallic material cannot be guaranteed.

[0004] Therefore, it is an urgent issue to provide a suitable armoring material and a structural type for the submarine cable currently used in great water depth.

SUMMARY

[0005] In view of above, an object of the present invention is to provide a non-metallic armored submarine cable, dead weight of which can be reduced by 25%-50% compared with the metal armored type of submarine cable, solving the difficult problem that the weight of the submarine cable and the force borne during vertical laying and installation are large under a condition of a great water depth, and achieving a lighter weight of the submarine cable while ensuring the mechanical properties of the deep submarine cable, such as tensile strength and compressive strength, thereby beneficial to ensuring the laying construction and operation safety of the submarine cable, and furthermore, the adopted non-metallic armoring element can withstand a pulling force above 1300 MPa, and can meet mechanical protection requirements of the cable at a great water depth of 3000 m or more.

[0006] In order to achieve the above object, a technical solution adopted by the present invention is as follows:

[0007] A non-metallic armored submarine cable, including a central cable consisting of one or more electric units, an armoring layer and an outer cladding layer, where the armoring layer is twisted around outside of the central cable, the outer cladding layer is sleeved outside the armoring layer, the outer cladding layer is formed by reversely tightly winding multi-layer polypropylene winding rope material, the armoring layer is formed by twisting a plurality of round or flat non-metallic armoring elements and/or a plurality of armoring metal wires, where

when the non-metallic armoring elements are round, the non-metallic armoring elements are formed by a non-metallic rod and an outer sheath extruded and wrapped outside the non-metallic rod, or the non-metallic armoring elements are formed by a central rod body

composed of a plurality of stacked non-metallic rods and an outer sheath extruded and wrapped outside the central rod body, and

when the non-metallic armoring elements are flat, the non-metallic armoring elements are formed by a central rod body composed of a plurality of horizontally arranged non-metallic rods and an outer sheath extruded and wrapped outside the central rod body.

[0008] Optionally, the non-metallic rod is a round rod structure, which is formed by impregnating aramid fiber material, fiber reinforced composite material or polyethylene material with polyurethane resin, and then heating and curing, a diameter of the round rod structure is 2-5 mm, the outer sheath is a protective layer structure formed by extruding and wrapping using a polymer, the protective layer structure has a thickness of 1-3 mm, and a density of 0.96-1.15 g/cm³.

[0009] Optionally, the non-metallic armoring elements have a density of 1.0-1.3 g/cm³, the non-metallic armoring elements have a diameter of 4-8 mm when the non-metallic armoring elements are round, the non-metallic armoring elements have a thickness of 3-5 mm and a width of 6-8 mm when the non-metallic armoring elements are flat, side edges of the non-metallic armoring elements are all provided with an arc chamfer with an arc radius of 0.2-0.8 mm.

[0010] Optionally, the central cable consists of one electric unit, the armoring layer includes a first armoring layer and a second armoring layer, where the first armoring layer is formed by twisting a plurality of round or flat non-metallic armoring elements and/or the plurality of armoring metal wires, the second armoring layer is formed by twisting the plurality of round or flat non-metallic armoring elements or formed by twisting the plurality of round or flat non-metallic armoring elements and the plurality of armoring metal wires that have the same shape as the non-metallic armoring elements and are spaced apart from the non-metallic armoring elements, a twisting direction of the first armoring layer is opposite to that of the second armoring layer.

[0011] Optionally, when the first armoring layer is formed by twisting a plurality of round non-metallic armoring elements, a plurality of optical fiber units are arranged in the first armoring layer, and the optical fiber units and the non-metallic armoring elements are symmetrically arranged at intervals.

[0012] Optionally, a wrapping tape layer or an inner liner layer is arranged between the first

armoring layer and the second armoring layer.

[0013] Optionally, the electric unit is sequentially provided with a waterproof conductor, a conductor shield layer, a conductor insulation layer, an insulation shield layer, a waterproof buffer layer, a metal shield layer and an inner sheath from inside to outside, where the inner liner layer is arranged between the armoring layer and the inner sheath.

[0014] Optionally, the central cable consists of a plurality of electric units, the armoring layer includes a first armoring layer and a second armoring layer, the first armoring layer is formed by twisting the plurality of round or flat non-metallic armoring elements and/or the plurality of armoring metal wires, the second armoring layer is formed by twisting the plurality of round or flat non-metallic armoring elements or formed by twisting the plurality of round or flat non-metallic armoring elements and the plurality of armoring metal wires, which have the same shape as the non-metallic armoring elements and are spaced apart from the non-metallic armoring elements, a twisting direction of the first armoring layer is opposite to that of the second armoring layer.

[0015] Optionally, the electric units each are sequentially provided with a waterproof conductor, a conductor shield layer, a conductor insulation layer, an insulation shield layer, a first waterproof buffer layer, a metal shield layer, a second waterproof buffer layer and an inner sheath from inside to outside, the plurality of the electric units are twisted to form a cable and are externally bundled with a wrapping tape layer, a gap between the wrapping tape layer and the plurality of electric units is provided with filling material to constitute a filling layer, an inner liner layer is arranged between the wrapping tape layer and the first armoring layer, the wrapping tape layer or the inner liner layer is arranged between the first armoring layer and the second armoring layer.

[0016] Optionally, a plurality of optical fiber units are further arranged in the gap between the wrapping tape layer and the plurality of electric units.

[0017] Compared with the prior art, the non-metallic armored submarine cable provided by the present invention has the following advantages:

[0018] 1) By adopting a conductor structure type of a special-shaped wire conductor, a waterproof filling material and an outer-wrapped semiconductive waterproof tape, tight compression coefficient of the conductor can reach 0.94-0.97, which is beneficial to improving

the waterproof effect of the submarine cable. The outer diameter of the conductor with the same specification is 0.4-1.5 mm smaller than that of the tightly compressed circular conductor structure, and the overall outer diameter of the submarine cable is reduced, which can significantly reduce the material cost.

5 **[0019]** 2) The surface hardness of the non-metallic armoring elements is lower than that of a metal material, such as a steel wire and a copper wire, which makes it easy to mold when the armor is twisted, and have a small internal stress. Therefore, it is easy to twist to form a multi-layer armoring structure, and the number of armoring layers can be 1-6 layers, and adjacent layers have opposite twisting directions, which is beneficial to the overall torque
10 balance of deep-sea cable, and prevents a side of submarine cable from being excessively bent and armor bulging when the armor is twisted in a same direction.

[0020] 3) A non-metallic rod in the non-metallic armoring element is formed by impregnating an aramid fiber material with polyurethane resin, and then heating and curing, has high modulus, high strength, high temperature resistance, corrosion resistance and aging
15 resistance, as well as good radial lateral pressure resistance and axial tensile capacities, which can significantly improve the overall strength of the non-metallic armoring element. The outer sheath outside the non-metallic rod is an extruded and wrapped polymer protective layer, has high material hardness, low density and is easy to mold. Different shapes of the outer sheath structures (round and flat) can be extruded by different extrusion dies, and at the same time, they
20 have good wear resistance and corrosion resistance, and is suitable for complex submarine cable environment conditions.

[0021] 4) The overall density of the non-metallic armoring element is $1.0\text{-}1.3\text{ g/cm}^3$, which is only 13%-17% of steel wire material and 11%-15% of copper wire. Under the same specification, the armoring layer has significant weight advantage, which can avoid a vertical stress caused by
25 an overweight metal armored submarine cable and an underwater tension, and ensure that the submarine cable is not damaged mechanically during construction and operation. Meanwhile, the consumption of expensive metal material is reduced, and the manufacturing cost of the submarine cable is reduced. The overall tensile strength of the non-metallic armoring element is not less than 1300 MPa, which is close to the tensile strength of 1250 grade medium carbon steel
30 wire, and can fully meet force conditions in construction, installation and operation of submarine

cable at a water depth of 3000 m or more.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] In order to more clearly explain embodiments of the present invention or the technical solutions in the prior art, the following will briefly introduce the drawings that need to be used in the description of the embodiments or the prior art. Obviously, the drawings in the following description are only some of embodiments of the present invention, and for those of ordinary skill in the art, other drawings can be obtained according to these drawings without creative efforts.

[0023] FIG. 1 is a structural schematic diagram of a non-metallic armoring element in a non-metallic armored submarine cable provided by the present invention where the non-metallic armoring element is round;

[0024] FIG. 2 is a structural schematic diagram of a non-metallic armoring element in a non-metallic armored submarine cable provided by the present invention where the non-metallic armoring element is flat;

[0025] FIG. 3 is a structural schematic diagram where a non-metallic armored submarine cable provided by the present disclosure is a single-core non-metallic armored cable HA;

[0026] FIG. 4 is a structural schematic diagram where a non-metallic armored submarine cable provided by the present disclosure is a single-core photoelectric composite non-metallic armored cable HB;

[0027] FIG. 5 is a structural schematic diagram where a non-metallic armored submarine cable provided by the present invention is a hybrid armored cable HC;

[0028] FIG. 6 is a structural schematic diagram where a non-metallic armored submarine cable provided by the present invention is a hybrid armored cable HD;

[0029] FIG. 7 is a structural schematic diagram where a non-metallic armored submarine cable provided by the present invention is a three-core non-metallic armored cable HE.

[0030] Description of main element symbols

Non-metallic rod	1
Outer sheath	2

	Non-metallic armoring element	FA1, FA2	
	Single-core non-metallic armored cable	HA	
	Waterproof conductor	HA1, HB1, HC1, HD1, HE1	
	Conductor shield layer	HA2, HB2, HC2, HD2, HE2	
5	Conductor insulation layer	HA3, HB3, HC3, HD3, HE3	
	Insulation shield layer	HA4, HB4, HC4, HD4, HE4	
	Waterproof buffer layer	HA5, HB5, HC5, HD5	
	Metal shield layer	HA6, HB6, HC6, HD6, HE6	
	Inner sheath	HA7, HB7, HC7, HD7, HE7	
10	Inner liner layer	HA8, HC8, HD8	
	First armoring layer	HA9, HB9, HC9, HD9, HE12	
	Wrapping tape layer	HA10, HB10, HC10, HD10, HE10	
	Second armoring layer	HA11、HB11、HC11、HD11、HE14	
	Outer cladding layer	HA12、HB12、HC12、HD12、HE15	
15	Single-core photoelectric composite non-metallic armored cable		HB
	Photoelectric unit	HB8	
	Hybrid armored cable	HC, HD	
	Armoring metal wire	TA	
	Three-core non-metallic armored cable	HE	
20	First waterproof buffer layer	HE5	
	Second waterproof buffer layer	HE7	
	Filling layer	HE9	
	Second inner liner layer	HE11	
	First inner liner layer	HE13	

25 DESCRIPTION OF EMBODIMENTS

[0031] The technical solutions of the present invention will be clearly and completely described below through embodiments. Obviously, the described embodiments are only some, but not all of embodiments of the present invention. Based on the embodiments in the present

invention, all other embodiments obtained by those of ordinary skill in the art without creative labor belong to the protection scope of the present invention.

[0032] A non-metallic armored submarine cable, where the submarine cable includes a central cable consisting of one or more electrical units, an armoring layer and an outer cladding layer. The armoring layer is twisted around the outside of the central cable, the outer cladding layer is sleeved around the outside of the armoring layer, and the outer cladding layer is formed by tightly winding two layers of polypropylene winding rope material in opposite directions.

[0033] In order to reduce the weight of the submarine cable, the armoring layer can at least be formed by twisting a plurality of round or flat non-metallic armoring elements and/or a plurality of armoring metal wires. The non-metallic armoring element has an overall tensile strength of 1300 MPa or more and a density of 1.0-1.3 g/cm³, and has a series of advantages, such as high strength, high hardness, low density, and wear resistance, and thus is suitable for being used as an armoring layer material of the submarine cable. The non-metallic armoring element includes a non-metallic rod 1 and an outer sheath 2, where the outer sheath 2 is sleeved outside the non-metallic rod 1. The non-metal rod 1 is a round rod structure which is formed by impregnating one of aramid fiber material, other fiber reinforced composite materials, such as carbon fiber, glass fiber, or coupling-modified ultrahigh molecular weight polyethylene material with polyurethane resin, and then heating and curing. The round rod structure has a diameter of 2-5 mm, the outer sheath 2 is a protective layer structure formed by extruding and wrapping using polymer, the protective layer structure has a thickness of 1-3 mm and a density of 0.96-1.15/cm³.

[0034] Referring to FIG. 1, when the non-metallic armoring element, as indicated by FA1, is round, the non-metallic armoring element consists of a non-metallic rod 1 and an outer sheath 2 extruded and wrapped outside the non-metallic rod 1, and a diameter of the non-metallic armoring element FA1 is 4-8 mm. Of course, the non-metallic armoring element FA1 can also be composed of a central rod body 1 composed of a plurality of stacked non-metallic rods 1 and an outer sheath 2 extruded and wrapped outside the central rod body, and this structure is not shown in the drawings. In the central rod body, two adjacent non-metallic rods 1 are arranged tangentially.

[0035] Referring to FIG. 2, when the non-metallic armoring element is flat, the non-metallic

armoring element consists of a central rod body composed of a plurality of horizontally arranged non-metallic rods 1 and an outer sheath 2 extruded and wrapped outside the central rod body. According to different width specifications, the non-metallic armoring element in flat structure can contain 1-3 non-metallic rods 1 inside thereof, which are arranged horizontally to increase the mechanical strength of the flat non-metallic armoring element. In FIG. 2, two non-metallic rods 1 arranged and distributed horizontally are taken as an example, and are indicated by FA2. The non-metal armoring element FA2 has a thickness of 3-5 mm and a width of 6-8 mm, side edges of the non-metallic armoring element are all provided with arc chamfers with an arc radius of 0.2-0.8 mm.

[0036] Embodiment 1

[0037] Referring to FIG. 3, this embodiment provides a single-core non-metallic armored cable HA, which sequentially consists of a waterproof conductor HA1, a conductor shield layer HA2, a conductor insulation layer HA3, an insulation shield layer HA4, a waterproof buffer layer HA5, a metal shield layer HA6, an inner sheath HA7, an inner liner layer HA8, a first armoring layer HA9, a wrapping tape layer HA10, a second armoring layer HA11 and an outer cladding layer HA12 from inside to the outside.

[0038] The waterproof conductor HA1 is formed by layered twisting of multiple aluminum wire materials, and each layer is filled with and coated with a seawater-proof waterproof glue. The individual wires are trapezoidal in shape, and have a resistivity of not more than $0.028264 \Omega \cdot \text{mm}^2/\text{m}$ at 20°C . The conductor is a structure type of a special-shaped wire conductor, and has a conductor section of 1600 mm^2 . The waterproof conductor HA1 is extruded and wrapped with a conductor shield HA2, the conductor shield HA2 is extruded and wrapped with an XLPE insulation HA3, the insulation is extruded and wrapped with an insulation shield HA4. The conductor shield layer HA2, the conductor insulation layer HA3 and the insulation shield layer HA4 adopt a three-layer co-extrusion type, and are extruded at one time, shielding materials used in the conductor shield layer HA2 and the insulation shield layer HA4 are semi-conductive shield materials based on ethylene-vinyl acetate copolymer (EVA) or ethylene-ethyl acrylate (EEA), and the conductor insulation layer HA3 is formed by heating, vulcanizing and cross-linking a mixture of polyethylene resin, crosslinking agent and antioxidant.

[0039] The insulation shield layer HA4 is cladded with a waterproof buffer layer HA5,

whose material is a seawater-proof semiconductive waterproof tape with high water absorption rate and expansion rate. The waterproof buffer layer HA5 is extruded and wrapped with a metal shield layer HA6, and a material of the metal shield layer HA6 is a seamless alloy lead sleeve and has purity of not less than 99.3%. The metal shield layer HA6 is extruded and wrapped with an inner sheath HA7, and a material of the inner sheath HA7 is semi-conductive polyethylene and has a material density of 1.15 g/cm³. The inner sheath HA7 is wrapped around the inner liner layer HA8, and the inner liner layer HA8 is a layer of polypropylene winding rope material.

[0040] The inner liner layer HA8 is twisted with a plurality of round non-metallic armoring elements FA1 to form the first armoring layer HA9 and the second armoring layer HA11. The diameter of the non-metallic armoring elements FA1 is 6.0 mm, and the two armoring layers have opposite twisting directions. A wrapping tape layer HA10 is wrapped between the two armoring layers, and the wrapping tape is made of high-strength wrapping tape material, such as PBT, polyester fiber tape, and glued cloth tape, and mainly plays the role of binding and fixing the first non-metallic armoring layer HA9. The second armoring layer HA11 is wrapped with two layers of reversely twisted polypropylene winding ropes as an outer cladding layer HA12.

[0041] Embodiment 2

[0042] Referring to FIG. 4, this embodiment provides a single-core photoelectric composite non-metallic armored cable HB, which sequentially consists of a waterproof conductor HB1, a conductor shield layer HB2, a conductor insulation layer HB3, an insulation shield layer HB4, a waterproof buffer layer HB5, a metal shield layer HB6, an inner sheath HB7, a optical fiber unit HB8, a first armoring layer HB9, a wrapping tape layer HB10, a second armoring layer HB11 and an outer cladding layer HB12 from inside to outside.

[0043] Where compared with example 1, the inner liner layer is removed in this structure, and meanwhile the diameter of the non-metallic armoring elements FA1 in the first armoring layer HB9 is 6.0 mm, two optical fiber units HB8 with a diameter of 5 mm are symmetrically placed in this armoring layer, and the armoring layers using the non-metallic armoring elements FA1 can play a role in protecting optical cable.

[0044] Embodiment 3

[0045] Referring to FIG. 5, this embodiment provides a hybrid armored cable HC, which sequentially consists of a waterproof conductor HC1, a conductor shield layer HC2, a conductor

insulation layer HC3, an insulation shield layer HC4, a waterproof buffer layer HC5, a metal shield layer HC6, an inner sheath HC7, an inner liner layer HC8, a first armoring layer HC9, a wrapping tape layer HC10, a second armoring layer HC11 and an outer cladding layer HC12 from inside to outside. Where except that the first armoring layer HC9 is formed by twisting a plurality of armoring copper wires TA, has a diameter of 6.0 mm, and has resistivity of not more than $0.01777 \Omega \cdot \text{mm}^2/\text{m}$ at 20°C , the other structures and adopted materials are the same as those in the Embodiment 1. The first armoring layer HC9 is formed by twisting a plurality of armoring copper wires TA, and its main function is to improve current-carrying capacity and short-circuit current of the submarine cable.

[0046] Embodiment 4

[0047] Referring to FIG. 6, this embodiment provides a hybrid armored cable HD, which sequentially consists of a waterproof conductor HD1, a conductor shield layer HD2, a conductor insulation layer HD3, an insulation shield layer HD4, a waterproof buffer layer HD5, a metal shield layer HD6, an inner sheath HD7, an inner liner layer HD8, a first armoring layer HD9, a wrapping tape layer HD10, a second armoring layer HD11 and an outer cladding layer HD12 from inside to outside. Where both the first armoring layer HD9 and the second armoring layer HD11 are composed of a plurality of round non-metallic armoring elements FA1 and armoring metal wires TA spaced apart from the non-metallic armoring elements FA1. The specifications of the armoring wires TA are the same as those of the non-metallic armoring elements FA1, the main purpose of which is to improve the current-carrying capacity and short-circuit current transmission capacity of the submarine cable. Other structures and materials in this embodiment are the same as those in Example 1.

[0048] Embodiment 5

[0049] Referring to FIG. 7, this embodiment provides a three-core non-metallic armored cable HE, and the electrical unit is sequentially provided with a waterproof conductor HE1, a conductor shield layer HE2, a conductor insulation layer HE3, an insulation shield layer HE4, a first waterproof buffer layer HE5, a metal shield layer HE6, a second waterproof buffer layer HE7, and an inner sheath HE8 from inside to outside, the three electrical units are tangentially abutted against each other and twisted into cables, and they are externally bundled with a wrapping tape layer HE10, and a filling material is arranged between the wrapping tape layer

HE10 and the three electrical units, so as to constitute a filling layer HE9. A second inner liner layer HE11, a first armoring layer HE12, a first inner liner layer HE13, a second armoring layer HE14 and an outer cladding layer HE15 are sequentially arranged outside the wrapping tape layer HE10.

5 **[0050]** The waterproof conductor HE1 is a circular conductor structure with a tightly pressed copper core, and has a conductor section of 500 mm². The material of individual circular wires of conductor is a TR type of annealed copper wire, and has resistivity of not more than 0.017241 Ω·mm²/m at 20°C. The conductor shield layer HE2, the conductor insulation layer HE3 and the insulation shield layer HE4 are coextruded in three layers, where the conductor insulation layer
10 HE3 is made of water-resistant tree type of insulation material, and the metal shield layer HE6 outside the insulation shield layer HE4 is a copper tape wrapped structure, and is made of 0.1 mm thick of copper tape material. The first waterproof buffer layer HE5 and the first waterproof buffer layer HE7 are wrapped inside and outside the metal shield layer HE6, respectively, and the material of the waterproof layers is seawater-proof semiconductive waterproof tape. The
15 inner sheath HE8 is extruded and wrapped outside the second waterproof buffer layer HE7, and the material of the inner sheath HE8 is semi-conductive polyethylene. After three inner sheaths HB8 are twisted into a cable, the interior of the cable has a filling layer HE9, the filling material of which is a polyethylene or rubber based hybrid filling strip structure, which plays a role in supporting and ensuring the roundness of the submarine cable. After forming into cable, the
20 outer layer of the inner sheath HE8 is wrapped with a wrapping tape layer HE10, a second inner liner layer HE11, a first armoring layer HE12, a first inner liner layer HE13, a second armoring layer HE14 and an outer cladding layer HE15. Where the second inner liner layer HE11, the first inner liner layer HE13 and the outer cladding layer HE15 are all formed by twisting polypropylene winding ropes; the first armoring layer HE12 and the second armoring layer
25 HE14 are all formed by twisting a plurality of flat non-metallic armoring elements FA2, the flat non-metallic armoring elements are 3.0 mm×7.0 mm in size, and the two layers have opposite twisting directions.

[0051] The present invention provides a non-metallic armored submarine cable, dead weight of which can be reduced by 25%-50% compared with a metal armored form, which solves the
30 difficult problem that the weight of the submarine cable and the force borne during vertical

laying installation are large under the condition of great water depth, and achieving a lighter weight of the submarine cable while ensuring the mechanical properties of the deep submarine cable, such as tensile strength and compressive strength, thereby beneficial to ensuring laying construction and operation safety of the submarine cable. The adopted non-metallic armoring elements can withstand a pulling force 1300 MPa or more, and can meet the mechanical protection requirements of the cable at a great water depth. The formed armoring layer structure can be suitable for all kinds of submarine cable structures at a water depth of 3000 m or more, and its application range includes a submarine optical cable, a submarine electric cable, a photoelectric composite cable, a dynamic cable, an umbilical cable and other underwater cables.

[0052] The above description of the disclosed embodiments enables those skilled in the art to realize or use the present invention. Many modifications to these embodiments will be obvious to those skilled in the art, and the general principles defined herein can be implemented in other embodiments without departing from the spirit or scope of the present invention. Therefore, the present invention will not be limited to the embodiments shown herein, but should be accorded with the widest scope consistent with the principles and novel features disclosed herein.

CLAIMS

1. A non-metallic armored submarine cable, characterized in that the submarine cable comprises a central cable consisting of one or more electric units, an armoring layer and an outer cladding layer, the armoring layer is twisted around outside of the central cable, the outer
5 cladding layer is sleeved outside the armoring layer, and is formed by reversely tightly winding a multi-layer polypropylene winding rope material, the armoring layer is formed by twisting a plurality of round or flat non-metallic armoring elements and/or a plurality of armoring metal wires, wherein

when the non-metallic armoring elements are round, the non-metallic armoring elements are
10 formed by a non-metallic rod and an outer sheath extruded and wrapped outside the non-metallic rod, or the non-metallic armoring elements are formed by a central rod body composed of a plurality of stacked non-metallic rods and an outer sheath extruded and wrapped outside the central rod body, and

when the non-metallic armoring elements are flat, the non-metallic armoring elements are
15 formed by a central rod body composed of a plurality of horizontally arranged non-metallic rods and an outer sheath extruded and wrapped outside the central rod body.

2. The non-metallic armored submarine cable according to claim 1, characterized in that the non-metallic rod is a round rod structure, which is formed by impregnating aramid fiber material, fiber reinforced composite material or polyethylene material with polyurethane resin, and then
20 heating and curing, a diameter of the round rod structure is 2-5 mm, the outer sheath is a protective layer structure formed by extruding and wrapping using a polymer, the protective layer structure has a thickness of 1-3 mm and a density of 0.96-1.15 g/cm³.

3. The non-metallic armored submarine cable according to claim 1, characterized in that the non-metallic armoring elements have a density of 1.0-1.3 g/cm³, the non-metallic armoring
25 elements have a diameter of 4-8 mm when the non-metallic armoring elements are round, the non-metallic armoring elements have a thickness of 3-5 mm and a width of 6-8 mm when the non-metallic armoring elements are flat, side edges of the non-metallic armoring elements are all provided with an arc chamfer with an arc radius of 0.2-0.8 mm.

4. The non-metallic armored submarine cable according to any one of claims 1 to 3,
30 characterized in that the central cable consists of one electric unit, the armoring layer comprises a first armoring layer and a second armoring layer, the first armoring layer is formed by twisting the plurality of round or flat non-metallic armoring elements and/or the plurality of armoring

metal wires, the second armoring layer is formed by twisting the plurality of round or flat non-metallic armoring elements, or formed by twisting the plurality of round or flat non-metallic armoring elements and the plurality of armoring metal wires that have the same shape as the non-metallic armoring elements and are spaced apart from the non-metallic armoring elements, and the first armoring layer and the second armoring layer have opposite twisting directions.

5 5. The non-metallic armored submarine cable according to claim 4, characterized in that when the first armoring layer is formed by twisting the plurality of round non-metallic armoring elements, a plurality of optical fiber units are arranged in the first armoring layer, wherein the optical fiber units and the non-metallic armoring elements are symmetrically arranged at
10 intervals.

6. The non-metallic armored submarine cable according to claim 4, characterized in that a wrapping tape layer or an inner liner layer is arranged between the first armoring layer and the second armoring layer.

7. The non-metallic armored submarine cable according to claim 4, characterized in that the
15 electric unit is sequentially provided with a waterproof conductor, a conductor shield layer, a conductor insulation layer, an insulation shield layer, a waterproof buffer layer, a metal shield layer and an inner sheath from inside to outside, wherein an inner liner layer is arranged between the armoring layer and the inner sheath.

8. The non-metallic armored submarine cable according to any one of claims 1 to 3,
20 characterized in that the central cable consists of a plurality of electric units, the armoring layer comprises a first armoring layer and a second armoring layer, the first armoring layer is formed by twisting the plurality of round or flat non-metallic armoring elements and/or the plurality of armoring metal wires, the second armoring layer is formed by twisting the plurality of round or flat non-metallic armoring elements, or formed by twisting the plurality of round or flat
25 non-metallic armoring elements and the plurality of armoring metal wires that have the same shape as the non-metallic armoring elements and are spaced apart from the non-metallic armoring elements, and the first armoring layer and the second armoring layer have opposite twisting directions.

9. The non-metallic armored submarine cable according to claim 8, characterized in that the
30 electric units are sequentially provided with a waterproof conductor, a conductor shield layer, a conductor insulation layer, an insulation shield layer, a first waterproof buffer layer, a metal shield layer, a second waterproof buffer layer and an inner sheath from inside to outside, the plurality of electric units are twisted to form a cable and are externally bundled with a wrapping tape layer, a gap between the wrapping tape layer and the plurality of electric units is provided

with a filling material to form a filling layer, an inner liner layer is arranged between the wrapping tape layer and the first armoring layer, and the wrapping tape layer or the inner liner layer is arranged between the first armoring layer and the second armoring layer.

5 10. The non-metallic armored submarine cable according to claim 9, characterized in that a plurality of optical fiber units are further arranged in a gap between the wrapping tape layer and the plurality of electric units.