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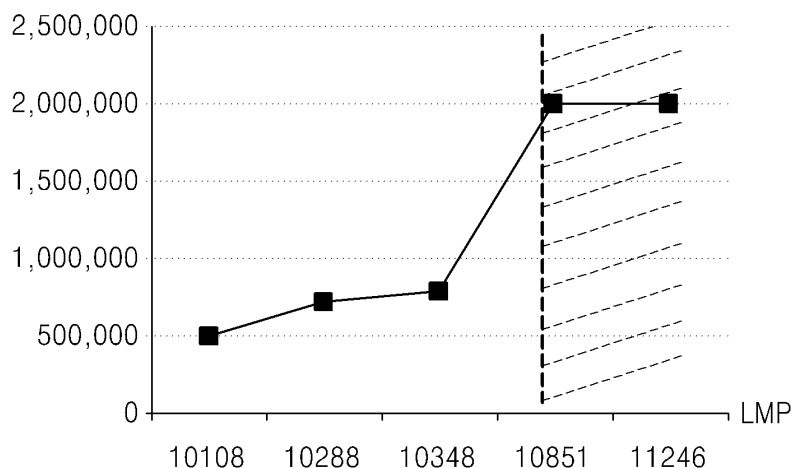
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(54) **COATED STEEL STRANDED CABLE, AND METHOD FOR MANUFACTURING SAME**

(57) A coated steel stranded cable including a plurality of strands, and one central strand, and a plurality of lateral strands stranded on an outside of the central strand, and the central strand and the lateral strands include, in weight%: 0.9 to 1.2% of carbon (C), 0.4 to 0.7%

of manganese (Mn), 1.0 to 1.5% of silicon (Si), 0.4 to 0.7% of chromium (Cr), less than 0.01 % of phosphor (P), less than 0.01% of sulfur (S), and a residual amount of iron (F) and other inevitable impurities.

Fig 3.



Description

TECHNICAL FIELD

[0001] The inventive concept relates to a high-strength coated steel stranded cable used in a bridge for a cable-stayed bridge and a civil engineering structure and a method for manufacturing the same, and more particularly, to a coated steel stranded cable having excellent fatigue characteristics by improving strength of about 20% or higher compared to a 1800 MPa grade coated steel stranded cable used in the related art and a method for manufacturing the same.

BACKGROUND ART

[0002] Coated steel stranded cables for cable-stayed bridges and construction support are used as significant materials for supporting loads of structures. These coated steel stranded cables are usually manufactured by cold drawing a cable material and then twisting a plurality of strands and performing heat treatment for removing residual deformation in a final process. The plurality of strands are generally galvanized. Uncoated steel stranded cables are used as the strands. Generally, the steel stranded cables have strength of about 1800 MPa.

[0003] In order to improve the strength of the coated steel stranded cables, a specific process, such as bluing treatment, have been performed, or various processes including adjusting types and ratios of materials for forming the coated steel stranded cables have been performed.

[0004] However, although, in the coated steel stranded cables used in the cable-stayed bridges, fatigue characteristics are very significant, activities for improving fatigue characteristics except for improving the strength of the coated steel stranded cables are minimal. That is, coated steel stranded cables having high strength used for bridges and a predetermined tensile strength and elongation and excellent fatigue characteristics acquired by devising component composition for manufacturing the coated steel stranded cables, cold drawing, zinc-aluminum alloy coating, secondary cold drawing and a stranding process need to be provided.

[0005] The inventive concept provides a high-strength coated steel stranded cable used in a bridge for a cable-stayed bridge and a civil engineering structure, that is, a coated steel stranded cable having excellent fatigue characteristics by improving strength of about 20% or higher compared to a 1800 MPa grade coated steel stranded cable used in the related art and a method for manufacturing the same.

TECHNICAL SOLUTION

[0006] According to an aspect of the inventive concept, there is provided a coated steel stranded cable comprising a plurality of strands, and one central strand, and a

plurality of lateral strands stranded on an outside of the central strand, and

the central strand and the lateral strands include, in weight%: 0.9 to 1.2% of carbon (C), 0.4 to 0.7% of manganese (Mn), 1.0 to 1.5% of silicon (Si), 0.4 to 0.7% of chromium (Cr), less than 0.01 % of phosphor (P), less than 0.01% of sulfur (S), and a residual amount of iron (F) and other inevitable impurities.

[0007] The coated steel stranded cable has a tensile strength of 2200 MPa or more and elongation of 7% or more.

[0008] The coated steel stranded cable of claim 1, further comprising a coated layer comprising zinc-aluminum.

[0009] According to an aspect of the inventive concept, there is provided a method for manufacturing a coated steel stranded cable, the method comprising:

performing constant temperature transformation heat treatment and primary cold drawing on a cable material including, in weight%: 0.9 to 1.2% of carbon (C), 0.4 to 0.7% of manganese (Mn), 1.0 to 1.5% of silicon (Si), 0.4 to 0.7% of chromium (Cr), less than 0.01% of phosphor (P), less than 0.01% of sulfur (S), and a residual amount of iron (F) and other inevitable impurities;

performing zinc-aluminum alloy coating on the cable material that is performed constant temperature transformation heat treatment and primary cold drawing;;

performing secondary drawing that manufacturing central strand and lateral strands on the cable material that is coated zinc-aluminum alloy; and performing twisting the lateral strands, wherein the secondary drawing is performed in a range of area reduction of 12 to 25%.

[0010] The method for manufacturing a coated steel stranded cable further comprise performing stress alleviation heat treatment performed when twisting the lateral strands, wherein a temperature and a maintenance time for stress alleviation heat treatment is obtained by the following Formula 1:

$$P(L.M.) = T[\log tr + C]$$

$$10800 < P(L.M.) < 11280,$$

where P(L.M.) is a heat treatment parameter, and T is temperature (K), tr is time (hr), and C is constant 20.

EFFECTS OF THE INVENTION

[0011] A coated steel stranded cable according to the inventive concept has relatively low surface residual

stress. The low surface residual stress reduces process nonuniformity, and elongation represents high toughness and favorably affects torsion and a fatigue characteristic value.

[0012] Thus, the coated steel stranded cable according to the inventive concept may be effectively used to support stress of a bridge for a cable-stayed bridge and a construction structure. The coated steel stranded cable having high strength increases a distance between pylons of the bridge so that construction of an extra-large bridge may be performed and stability and esthetic design may be performed.

DESCRIPTION OF THE DRAWINGS

[0013]

FIG. 1 is a view of a coated steel stranded cable according to an exemplary embodiment.

FIG. 2 is a view of a cross section of the coated steel stranded cable according to an exemplary embodiment.

FIG. 3 is a table showing the number of fatigue cycles according to stress alleviation heat treatment conditions.

FIG. 4 is a table showing the result of testing according to conditions for manufacturing a coated steel stranded cable.

BEST MODE

[0014] According to an aspect of the inventive concept, there is provided a coated steel stranded cable comprising a plurality of strands, and one central strand, and a plurality of lateral strands stranded on an outside of the central strand, and

the central strand and the lateral strands include, in weight%: 0.9 to 1.2% of carbon (C), 0.4 to 0.7% of manganese (Mn), 1.0 to 1.5% of silicon (Si), 0.4 to 0.7% of chromium (Cr), less than 0.01 % of phosphor (P), less than 0.01% of sulfur (S), and a residual amount of iron (F) and other inevitable impurities.

MODE OF THE INVENTIVE CONCEPT

[0015] Hereinafter, exemplary embodiments of the inventive concept will be described with reference to the accompanying drawings.

[0016] Exemplary embodiments of the inventive concept will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings. The present invention may, however, be embodied in many different forms and should not be construed as being limited to the exemplary embodiments set forth herein. Like reference numerals refer to like elements.

[0017] Spatially relative terms, such as "inside" or "outside", may be used herein, for the purpose of describing

the relationship between some elements with respect to other elements, as illustrated in the drawings. The spatially relative terms may be understood to intend to include other directions of an element in addition to a direction illustrated in the drawings. For example, when the element is switched in opposite position in the drawings, elements described to be disposed on top surfaces of other elements have directions on bottom surfaces of the other elements. Thus, the term "on" may include all of directions "under" and "on" depending on a particular direction in the drawings. When an element is directed in another direction, spatially relative descriptions used herein may be interpreted accordingly.

[0018] The terminology used herein is used to describe particular embodiments only and is not intended to be limiting of the invention. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," or "includes" and/or "including" when used in this specification, specify the presence of stated features, regions, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, regions, integers, steps, operations, elements, components, and/or groups thereof

[0019] Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

[0020] In the drawings, the thickness or size of each element is exaggerated, omitted, or schematically illustrated for convenience of explanation and clarity. Also, the size and area of each component do not entirely reflect actual size and area.

[0021] Also, a direction mentioned while the structure of the inventive concept is described in an exemplary embodiment, is based on the drawings. When a reference point with respect to the direction and a position relation are not clearly mentioned in the description of the structure that forms the inventive concept, the related drawings will be referred to.

[0022] FIGS. 1 and 2 are views of a coated steel stranded cable 1 according to an exemplary embodiment of the inventive concept.

[0023] Referring to FIGS. 1 and 2, the coated steel stranded cable 1 according to an exemplary embodiment of the inventive concept includes a central strand 10 and a plurality of lateral strands 20 that are stranded on an outside of the central strand 10 and constitutes an outside of an outer layer.

[0024] Preferably, as illustrated in FIGS. 1 and 2, the

coated steel stranded cable 1 according to the inventive concept includes one central strand 10 and six lateral strands 20. Embodiments of the inventive concept are not limited thereto.

[0025] The central strand 10 and the lateral strands 20 may be formed to have the same configuration or may be configured to have different inner diameters or materials. However, embodiments of the inventive concept are not limited thereto. Each of the lateral strands 20 has a predetermined twisted pitch P and is periodically stranded on the outside of the central strand 10.

[0026] Hereinafter, a component system and a composition range of materials that form the central strand 10 and the lateral strands 20 of the inventive concept will be described in detail.

[0027] Carbon (C) : 0.9 to 1.2 weight%

[0028] Carbon (C) is an element that is most effective and economical to improving strength of steel. Carbon (C) is an element forming cementite in a pearlite tissue of steel. As the content of C increases, a fraction of cementite having high strength is increased, and a distance between layers of a pearlite lamella is fine and thus strength may be increased. Thus, more than 0.9% of C is required to obtain strength of 2200 MPa or more. When the content of C that exceeds 1.2% is added, precipitation of proeutectoid cementite may occur. Thus, required ductility is rapidly lowered. Thus, the upper limit of C is set to be 1.2%.

Manganese (Mn) : 0.2 to 0.7 weight%

[0029] Manganese (Mn) is an element that is dissolved in a ferrite tissue, increases the strength of steel, increases hardenability and delays transformation of pearlite. More than 0.2% of Mn is required to obtain the fine pearlite tissue even at slightly low cooling speed. Center segregation occurs in excessive Mn, and a martensite tissue is generated in the centre of Mn, which lowers drawing performance. Thus, the upper limit of Mn is set to be 0.7%.

Silicon (Si) : 0.4 to 0.7 weight%

[0030] Silicon (Si) that is an element for dissolving and reinforcing ferrite in pearlite is effective for making high strength. Si prevents strength effect by suppressing decomposition of cementite when galvanizing or zinc-aluminium alloy coating is performed. Thus, more than 1.0% of Si is required to be added for high strength. When the content of Si exceeds 1.5%, ductility of ferrite is rapidly reduced, which may cause surface tissue defects. Thus, the upper limit of Si is set to be 1.5%.

Chromium (Cr) : 0.4 to 0.7 weight%

[0031] Chromium (Cr) is used to make the distance between layers of the pearlite lamella fine so that strength and ductility affect suppressing of decomposition of cementite. When the content of Cr is less than 0.4%, sufficient

strength is not obtained. When the content of Cr exceeds 0.7%, a constant temperature transformation termination time is increased so that productivity is lowered and there is a high possibility that the martensite tissue will be generated. Thus, about 0.4 to 0.7% of Cr is added.

Sulfur (S) : less than 0.01 weight %

[0032] When the content of sulfur (S) exceeds 0.01%, S having a shape of a low melting point precipitate is precipitated in a grain boundary, which causes hot embrittlement. Thus, the content of Si may be controlled to be less than 0.01%.

Phosphor (P) : less than 0.01 weight %

[0033] When the content of phosphor (P) exceeds 0.01%, P is segregated between columnar zones, which causes hot embrittlement and cracks during cold drawing. Thus, the content of P may be controlled to be less than 0.01%.

[0034] The central strand 10 and the lateral strands 20 includes a residual amount of iron (F) and other inevitable impurities except for the above-described compositions.

[0035] Hereinafter, a method for manufacturing the high-strength zinc-aluminium coated steel stranded cable 1 having excellent fatigue characteristics according to the inventive concept will be described.

[0036] First, after constant temperature transformation heat treatment is performed on a cable material that contains the above components, primary cold drawing is performed in 9 paths. After zinc-aluminium alloy coating is performed after primary cold drawing, secondary drawing is performed. By performing secondary drawing, a central strand 10 and lateral strands 20 for the steel stranded cable having 2200 MPa or more final desired tensile strength are manufactured.

[0037] In this case, secondary drawing is performed in a range in which spiral cracks do not occur in a twisting test when strength of the central strand 10 and the lateral strands 20 is 2200 MPa or more. That is, when area reduction of drawing after coating is 12% or more, 2200 MPa tensile strength may be obtained. Thus, although lowest area reduction of drawing after coating is maintained to be 12%, when the amount of drawing exceeds 25%, twisting characteristics of the lateral strands 20 and the central strand 10 may be reduced. When the steel stranded cable is manufactured in a state in which spiral cracks occur, fatigue characteristics and elongation may be lowered. Thus, area reduction of drawing after coating is limited to 12 to 25%.

[0038] Meanwhile, when the high-strength zinc-aluminium coated steel stranded cable 1 having excellent fatigue characteristics according to the inventive concept is manufactured by twisting the lateral strands 20, stress alleviation heat treatment is performed. In this case, a temperature and a maintenance time for stress allevia-

tion heat treatment are as shown in the following Formula 1.

$$P(L.M.) = T[\log tr + C] \quad (\text{Formula 1})$$

$$10800 < P(L.M.) < 11280,$$

where P(L.M.) is a heat treatment parameter, and T is temperature (K), tr is time (hr), and C is constant 20.

[0039] Here, P(L.M.) is a heat treatment parameter, and T is temperature (K), and tr is time (hr), and C is constant 20.

[0040] The reason why P(L.M.) is set to be equal to or greater than 10800 and equal to or less than 11280 according to the stress alleviation heat treatment temperature and maintenance time, is that, when P(L.M.) is equal to or less than 10800, sufficient stress alleviation heat treatment is not performed, and fatigue characteristics are lowered and when P(L.M.) is equal to or greater than 11280, the stress alleviation heat treatment temperature exceeds 382°C that is a zinc-aluminium melting point and thus a coated layer may be melted.

[0041] FIG. 3 is a table showing the number of fatigue cycles according to these stress alleviation heat treatment conditions.

[0042] As shown in FIG. 3, when a P(L.M.) value is about 10800 or more, the number of fatigue cycles is increased.

[0043] The result of a fatigue test regarding the high-strength zinc-aluminium coated steel stranded cable 1 having excellent fatigue characteristics manufactured using the manufacturing method and on these conditions is shown in FIG. 4 that will be described below. FIG. 4 is a table showing the result of testing according to conditions for manufacturing the steel stranded cable. In this case, a fatigue test was performed using a 50 ton hydraulic tester, and a maximum load was 45% of a tensile strength, and a stress amplitude was 300 MPa so that, when the test was performed from one time to 2,000,000 times without a break, it was determined that the test was passed.

[0044] Furthermore, elongation (%) of the steel stranded cable shown in FIG. 4 was measured using an extension meter that is an Instron 50 ton tensile tester, and residual stress was measured using an X-ray diffractometer (XRD).

[0045] Referring to FIG. 4, elongation (%) of inventive concept examples 1 and 2 is higher than that of comparative examples 1, 2, and 3. Surface residual stress of inventive concept examples 1 and 2 is relatively low compared to that of comparative examples 1, 2, and 3. Low surface residual stress reduces process nonuniformity, and elongation represents high toughness and favorably affects torsion and a fatigue characteristic value.

[0046] Thus, the coated steel stranded cable accord-

ing to the inventive concept may be effectively used to support stress of a bridge for a cable-stayed bridge and a construction structure. The coated steel stranded cable having high strength increases a distance between pylons of the bridge so that construction of an extra-large bridge may be performed and stability and esthetic design may be performed.

[0047] While the inventive concept has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood that various changes in form and details may be made therein without departing from the spirit and scope of the following claims.

Claims

1. A coated steel stranded cable comprising a plurality of strands, and one central strand, and a plurality of lateral strands stranded on an outside of the central strand, and the central strand and the lateral strands include, in weight%: 0.9 to 1.2% of carbon (C), 0.4 to 0.7% of manganese (Mn), 1.0 to 1.5% of silicon (Si), 0.4 to 0.7% of chromium (Cr), less than 0.01% of phosphorus (P), less than 0.01% of sulfur (S), and a residual amount of iron (F) and other inevitable impurities.
2. The coated steel stranded cable of claim 1, wherein the coated steel stranded cable has a tensile strength of 2200 MPa or more and elongation of 7% or more.
3. The coated steel stranded cable of claim 1, further comprising a coated layer comprising zinc-aluminum.
4. A method for manufacturing a coated steel stranded cable, the method comprising:

performing constant temperature transformation heat treatment and primary cold drawing on a cable material including, in weight%: 0.9 to 1.2% of carbon (C), 0.4 to 0.7% of manganese (Mn), 1.0 to 1.5% of silicon (Si), 0.4 to 0.7% of chromium (Cr), less than 0.01% of phosphorus (P), less than 0.01% of sulfur (S), and a residual amount of iron (F) and other inevitable impurities;

performing zinc-aluminum alloy coating on the cable material that is performed constant temperature transformation heat treatment and primary cold drawing;

performing secondary drawing that manufacturing central strand and lateral strands on the cable material that is coated zinc-aluminum alloy; and

performing twisting the lateral strands,

wherein the secondary drawing is performed in a range of area reduction of 12 to 25%.

5. The method of claim 4, further comprising performing stress alleviation heat treatment performed when twisting the lateral strands, wherein a temperature and a maintenance time for stress alleviation heat treatment is obtained by the following Formula 1:

$$P(L.M.) = T[\log tr + C]$$

$$10800 < P(L.M.) < 11280,$$

where P(L.M.) is a heat treatment parameter, and T is temperature (K), tr is time (hr), and C is constant 20.

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Fig 1.

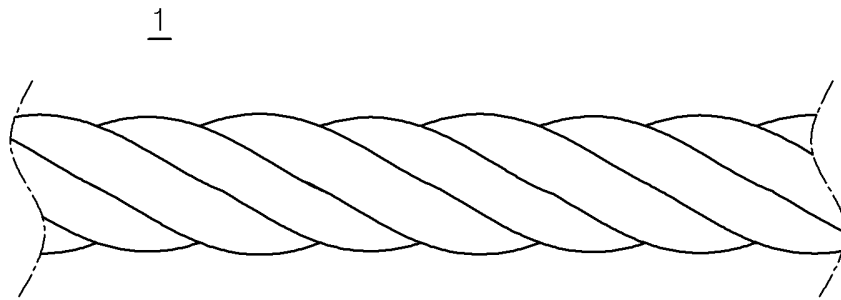


Fig 2.

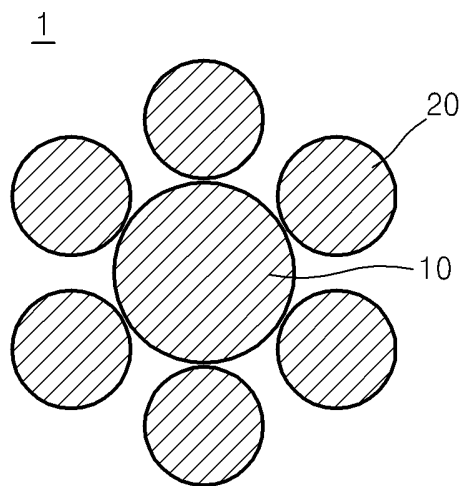


Fig 3.

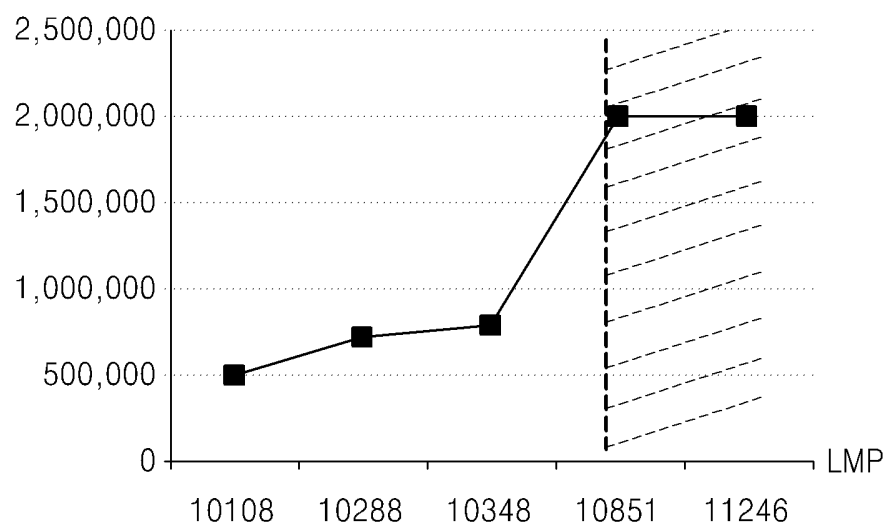


Fig 4.

SAMPLE	CONDITIONS FOR MANUFACTURING STEEL STRANDED CABLE						TEST RESULT		
	COATED	LOAD (kgf)	PITCH (mm)	HEAT TREATMENT TEMPERATURE (°C)	HEAT TREATMENT TIME (S)	LMP $P(L,M)=T[\log t+C]$	FATIGUE TEST(Cycle) (TS * 0.45, $\Delta\sigma=300MPa$)	ELONGATION (%)	SURFACE RESIDUAL STRESS (MPa)
INVENTIVE CONCAPT EXAMPLE 1	O	16,000	223	360	5	10851	2,000,000	7~9	-132.5±18.6
INVENTIVE CONCAPT EXAMPLE 2	X	16,500	231	380	6	11246	2,000,000	7~9	-59.9±19.7
COMPARATIVE EXAMPLE 1	O	16,000	228	320	4	10108	490,000	5~6	+71.6±9.9
COMPARATIVE EXAMPLE 2	O	16,500	228	345	2	10348	790,000	5~6	+103.±24.10
COMPARATIVE EXAMPLE 3	O	16,500	228	335	3	10288	710,000	5~6	+209.5±93.4