

# US Patent & Trademark Office

## Patent Public Search | Text View

---

United States Patent	12384466
Kind Code	B2
Date of Patent	August 12, 2025
Inventor(s)	Ito; Hiroyasu

---

### Vehicle body pillar structure and vehicle body structure

---

#### Abstract

A vehicle body pillar structure includes a cylindrical member and an outer layer member. The cylindrical member is formed from a carbon fiber-reinforced resin. The outer layer member is provided on an outer circumference of the cylindrical member and is formed from a carbon fiber-reinforced resin. The outer layer member includes a recessed groove provided on a surface of the outer layer member closer to the cylindrical member, recessed in a direction away from the cylindrical member, and extending along an axial direction of the cylindrical member. A fiber-reinforced resin is disposed in the recessed groove. The fiber-reinforced resin contains continuous fibers wound around pin members provided on both axial sides of the recessed groove and is oriented along the axial direction of the cylindrical member.

---

<b>Inventors:</b>	<b>Ito; Hiroyasu (Tokyo, JP)</b>
<b>Applicant:</b>	<b>SUBARU CORPORATION (Tokyo, JP)</b>
<b>Family ID:</b>	<b>1000008751491</b>
<b>Assignee:</b>	<b>SUBARU CORPORATION (Tokyo, JP)</b>
<b>Appl. No.:</b>	<b>18/165607</b>
<b>Filed:</b>	<b>February 07, 2023</b>

#### Prior Publication Data

<b>Document Identifier</b>	<b>Publication Date</b>
US 20230264748 A1	Aug. 24, 2023

#### Foreign Application Priority Data

JP	2022-024474	Feb. 21, 2022
----	-------------	---------------

---

#### Publication Classification

**Int. Cl.:** B62D25/04 (20060101); B62D23/00 (20060101); B62D25/08 (20060101); B62D27/06 (20060101); B62D29/04 (20060101)

**U.S. Cl.:**

**CPC** B62D25/04 (20130101); B62D23/005 (20130101); B62D25/08 (20130101); B62D27/065 (20130101); B62D29/043 (20130101);

## Field of Classification Search

**CPC:** B62D (25/04); B62D (25/08); B62D (23/005); B62D (27/065); B62D (29/043); B62D (29/04)

**USPC:** 296/193.06; 296/901.01; 296/209; 296/23.01; 296/3; 296/210

---

## References Cited

### U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
4821447	12/1988	Nakayama	43/18.5	A01K 87/06
10173363	12/2018	Boveroux	N/A	B29C 70/06
11559977	12/2022	Visini	N/A	B41F 5/24

### FOREIGN PATENT DOCUMENTS

Patent No.	Application Date	Country	CPC
2013-193637	12/2012	JP	N/A
2015-160524	12/2014	JP	N/A

---

*Primary Examiner:* Pedder; Dennis H

*Attorney, Agent or Firm:* Smith, Gambrell & Russell, LLP

---

## Background/Summary

### CROSS-REFERENCE TO RELATED APPLICATIONS

(1) The present application claims priority from Japanese Patent Application No. 2022-024474 filed on Feb. 21, 2022, the entire contents of which are hereby incorporated by reference.

### BACKGROUND

(2) The disclosure relates to a vehicle body pillar structure and a vehicle body structure of a motor vehicle using a fiber-reinforced resin composite.

(3) For weight reduction of a vehicle body of a vehicle such as a passenger vehicle, it has recently been considered to manufacture a vehicle body structural material using a fiber-reinforced resin typified by a carbon fiber-reinforced resin (hereinafter, “CFRP”). The structural material made of the fiber-reinforced resin has high rigidity and exhibits high strength particularly against a compressive stress or a tensile stress acting in a fiber orientation direction. Even when the structural material for the vehicle body is configured using the fiber-reinforced resin, it is desired to ensure rigidity to resist a collision, a joint strength for joining with other components of the vehicle.

(4) Vehicle body structures formed from a carbon fiber-reinforced resin composite are proposed in,

for example, Japanese Unexamined Patent Application Publication (JP-A) Nos. 2015-160524 and 2013-193637. In an example, JP-A No. 2015-160524 discloses a center pillar structure where an inner wall, in a vehicle width direction, of a B-pillar of a metal hollow frame that is a tensile side during input of a collision load of a side collision is reinforced with a CFRP reinforcing member. In addition, JP-A No. 2013-193637 discloses a vehicle cabin structure where a center pillar formed from the CFRP together with a roof arch is coupled to a side sill formed from the CFRP together with a floor member via a coupling member of an aluminum foundry piece.

## SUMMARY

- (5) An aspect of the disclosure provides a vehicle body pillar structure including a cylindrical member and an outer layer member. The cylindrical member is formed from a carbon fiber-reinforced resin. The outer layer member is provided on an outer circumference of the cylindrical member and is formed from a carbon fiber-reinforced resin. The outer layer member includes a recessed groove provided on a surface of the outer layer member closer to the cylindrical member, recessed in a direction away from the cylindrical member, and extending along an axial direction of the cylindrical member. A fiber-reinforced resin is disposed in the recessed groove. The fiber-reinforced resin contains continuous fibers wound around pin members provided on both axial sides of the recessed groove and are oriented along the axial direction of the cylindrical member.
- (6) An aspect of the disclosure provides a vehicle body structure including a vehicle body pillar structure. The vehicle body pillar structure includes a cylindrical member and an outer layer member. The cylindrical member is formed from a carbon fiber-reinforced resin. The outer layer member is provided on an outer circumference of the cylindrical member and is formed from a carbon fiber-reinforced resin. The outer layer member includes a recessed groove provided on a surface of the outer layer member closer to the cylindrical member, recessed in a direction away from the cylindrical member, and extending along an axial direction of the cylindrical member. A fiber-reinforced resin is disposed in the recessed groove. The fiber-reinforced resin contains continuous fibers wound around pin members provided on both axial sides of the recessed groove and is oriented along the axial direction of the cylindrical member.
- 

## Description

### BRIEF DESCRIPTION OF THE DRAWINGS

- (1) The accompanying drawings are included to provide a further understanding of the disclosure and are incorporated in and constitute a part of this specification. The drawings illustrate an embodiment and, together with the specification, serve to describe the principles of the disclosure.
- (2) FIG. 1 is a schematic diagram illustrating overall configurations of a vehicle body side structure according to an embodiment.
- (3) FIG. 2 is a plan view and a cross-sectional view illustrating configurations of a center pillar according to the present embodiment.
- (4) FIG. 3 is a cross-sectional view illustrating the configurations of the center pillar according to the present embodiment.
- (5) FIG. 4 illustrates an inner surface of an inner member of the center pillar according to the present embodiment.
- (6) FIG. 5 illustrates a configuration example of using a pin member provided on a bottom of the center pillar according to the present embodiment as part of a coupling structure.

### DETAILED DESCRIPTION

- (7) When a CFRP is applied to a center pillar, it is desirable to maintain fiber continuity to make effective use of characteristics of the CFRP described above. In one example, it is desirable that reinforcement fibers are disposed as continuously as possible in a length or circumferential direction of the center pillar. Therefore, as with the metal center pillar described in JP-A No. 2015-

160524, when a CFRP outer member and a CFRP inner member are each formed to have a hat cross-section and the outer member is bonded to the inner member simply in flanges on both ends, the fiber continuity at least in the circumferential direction of the center pillar may not be able to be maintained. Furthermore, simply bonding the outer member to the inner member simply in the flanges on both sides may result in insufficient bonding strength.

(8) By contrast, a CFRP cylindrical member is disposed between an outer member and an inner member and the outer member and the inner member are joined to the cylindrical member. This can provide a closed cross-sectional structure capable of maintaining the continuity of the reinforcement fibers while ensuring the bonding strength. At this time, the inner member that serves to receive a load during an input of a collision load of a side collision is formed to have an uneven cross-section. This can increase a section modulus and rigidity. However, with the uneven cross-section, bonded surfaces of the members with the cylindrical member decrease, which may reduce the bonding strength. In addition, the inner member configured simply with the CFRP has a minor breaking strain and may not be able to prevent breaks sufficiently.

(9) Therefore, it is desirable to provide a vehicle body pillar structure and a vehicle body structure capable of maintaining a bonding strength for bonding a cylindrical member to an outer layer member of a CFRP pillar and having high rigidity against a collision load of a side collision.

(10) In the following, an embodiment of the disclosure is described in detail with reference to the accompanying drawings. Note that the following description is directed to an illustrative example of the disclosure and not to be construed as limiting to the disclosure. Factors including, without limitation, numerical values, shapes, materials, components, positions of the components, and how the components are coupled to each other are illustrative only and not to be construed as limiting to the disclosure. Further, elements in the following example embodiment which are not recited in a most-generic independent claim of the disclosure are optional and may be provided on an as-needed basis. The drawings are schematic and are not intended to be drawn to scale. Throughout the present specification and the drawings, elements having substantially the same function and configuration are denoted with the same numerals to avoid any redundant description.

(11) An outline of a vehicle body structure with a vehicle body center pillar structure according to an embodiment will first be described.

(12) FIG. 1 is a schematic diagram illustrating an appearance of a vehicle body side structure 1. The vehicle body side structure 1 illustrated in FIG. 1 is a schematic view of part of a left side structure of a vehicle. As illustrated in FIG. 1, in the present specification, a vehicle width direction may be denoted as an X direction, a vehicle body longitudinal direction (vehicle length direction) may be represented as a Y direction, and a vehicle height direction may be denoted as a Z direction.

(13) The vehicle body side structure 1 is configured with a roof pillar 5, a rear pillar 4, a front pillar 2, a center pillar 3, a side sill 6, and the like. The roof pillar 5 extends above a vehicle cabin space of a vehicle along the vehicle longitudinal direction and forms a side of a vehicle roof. The side sill 6 extends below the side of the vehicle along the vehicle longitudinal direction.

(14) The front pillar 2 has a lower end coupled to a front end of the side sill 6 and an upper end coupled to a front end of the roof pillar 5. The front pillar 2 forms a front that configures the vehicle cabin space of the vehicle and is disposed to support a side of a windshield. The rear pillar 4 has a lower end coupled to a rear end of the side sill 6 and an upper end coupled to a rear end of the roof pillar 5. The center pillar 3 has a lower end coupled to a center, in the vehicle longitudinal direction, of the side sill 6 and an upper end coupled to a center, in the vehicle longitudinal direction, of the roof pillar 5.

(15) An opening for a front door is formed between the side sill 6, the roof pillar 5, the front pillar 2, and the center pillar 3. In addition, an opening for a rear door is formed between the side sill 6, the roof pillar 5, the rear pillar 4, and the center pillar 3. Each member configuring the vehicle body side structure 1 may be configured with multiple members. For example, each member may be configured such that an outer panel in the vehicle width direction is bonded to an inner panel in the

vehicle width direction.

(16) In this vehicle body side structure **1**, a longitudinal direction of the center pillar **3** is the vehicle height direction, and the center pillar **3** is formed into a generally cylindrical shape. The center pillar **3** has a roof pillar coupling part **16** provided on the upper end, a side sill coupling part **14** provided on the lower end, and a pillar main body **12** located between the roof pillar coupling part **16** and the side sill coupling part **14**. In the present embodiment, the center pillar **3** is formed from a carbon fiber-reinforced resin (CFRP).

(17) Configurations of the center pillar **3** according to the present embodiment will next be described in detail.

(18) FIGS. **2** to **4** illustrate the configurations of the center pillar **3** according to the present embodiment. The center pillar **3** illustrated in FIGS. **2** to **4** is a simplified view of the center pillar **3** of the vehicle body side structure **1** illustrated in FIG. **1**. In FIG. **2**, the center pillar **3** viewed from a vehicle body outer direction is at the center, the center pillar **3** viewed from a vehicle body inner direction is at the left, and an arrow view of an I-I cross-section is at the right. FIG. **3** is an arrow view of a II-II cross-section of the center pillar **3** illustrated in FIG. **2**. FIG. **4** illustrates an inner surface of an inner member **21** of the center pillar **3**.

(19) The center pillar **3** includes the inner member **21** located inside of the vehicle body, an outer member **31** located outside of the vehicle body, and a cylindrical member **41** located between the inner member **21** and the outer member **31**. The inner member **21**, the outer member **31**, and the cylindrical member **41** are each formed from the CFRP. Among these members, the inner member **21** and the outer member **31** correspond to outer layer members provided on an outer circumference of the cylindrical member **41**.

(20) The inner member **21** and the outer member **31** each have a part configuring the roof pillar coupling part **16** on an upper end and a part configuring the side sill coupling part **14** on a lower end. In addition, the inner member **21** has flanges **21a**, **21b** on both sides, in the vehicle longitudinal direction, of an intermediate member configuring the pillar main body **12**. The outer member **31** has flanges **31a**, **31b** on both sides, in the vehicle longitudinal direction, of an intermediate member configuring the pillar main body **12**. The cylindrical member **41** is formed into a hollow cylindrical shape to have a stereoscopic shape corresponding to a shape of the pillar main body **12**.

(21) The roof pillar coupling part **16** and the side sill coupling part **14** are configured with upper ends and lower ends of the inner member **21** and the outer member **31**, respectively. The roof pillar coupling part **16** and the side sill coupling part **14** are formed into groove shapes fitted into the roof pillar **5** and the side sill **6**, respectively and extending in the vehicle longitudinal direction. However, the shapes of the roof pillar coupling part **16** and the side sill coupling part **14** are not limited to the groove shapes.

(22) The pillar main body **12** has a generally cylindrical shape with an axial direction extending along the vehicle height direction. The pillar main body **12** is configured as a compact having a cylindrical closed cross-section. That is, the cylindrical member **41** is put between the inner member **21** and the outer member **31**, inner surfaces of the inner member **21** and the outer member **31** are bonded to an outer surface of the cylindrical member **41**, and the flanges **21a**, **21b** of the inner member **21** are bonded to the flanges **31a**, **31b** of the outer member **31** (refer to FIG. **3**). The inner member **21** and the outer member **31** are bonded to the cylindrical member **41** and the flanges **21a**, **21b** are bonded to the flanges **31a**, **31b** of the outer member **31** by, for example, an adhesive. The flanges **21a**, **21b** and the flanges **31a**, **31b** bonded to one another can be used as, for example, doorstops of the front door and the rear door.

(23) The cylindrical member **41** is formed with a fiber-reinforced resin where carbon fibers are impregnated with a thermoplastic resin or a thermosetting resin. Examples of the thermoplastic resin include a polyethylene resin, a polypropylene resin, a polyvinyl chloride resin, an ABS resin (acrylonitrile-butadiene-styrene copolymer synthetic resin), a polystyrene resin, an AS resin

(acrylonitrile-styrene copolymer synthetic resin), a polyamide resin, a polyacetal resin, a polycarbonate resin, a polyester resin, a PPS (polyphenylene sulfide) resin, a fluorocarbon resin, a polyetherimide resin, a polyether ketone resin, and a polyimide resin.

(24) One or a mixture of two types or more of the thermoplastic resins can be used as a matrix resin. Alternatively, the matrix resin may be a copolymer of these thermoplastic resins. When the mixture of the thermoplastic resins is used, a compatibilizer may be added to the mixture.

Furthermore, a fire retardant such as a bromine-based fire retardant, a silicon-based fire retardant, or red phosphorus may be added to the thermoplastic resin(s).

(25) Examples of the thermosetting resin include an epoxy resin, an unsaturated polyester resin, a vinyl ester resin, a phenol resin, a polyurethane resin, and a silicon resin. One or a mixture of two types or more of the thermosetting resins can be used as the matrix resin. When one or more of these thermosetting resins are used, a curing agent and a reaction accelerator may be added as appropriate to the thermosetting resin(s).

(26) The carbon fibers may include fibers oriented in the axial direction and those oriented in a direction crossing the axial direction at an appropriate ratio. A tensile stress generated during input of a collision load of a side collision is adjusted depending on an amount of the fibers oriented in the axial direction. A rigidity against the collision load of the side collision is adjusted and an absorbed amount of collision energy is adjusted depending on an amount of the fibers oriented in the direction crossing the axial direction. Since the cylindrical member **41** is the compact having the cylindrical closed cross-section, it is possible to maintain not only the continuity of the fibers in the axial direction (vehicle longitudinal direction) but also the continuity of the fibers in the circumferential direction around an axis. Therefore, it is possible to improve the rigidity against the collision load of the side collision.

(27) The cylindrical member **41** may be a hollow tubular member or a solid member filled with a resin or the other appropriate material. Furthermore, the cylindrical member **41** may contain short fibers other than continuous fibers and may contain fibers other than carbon fibers as reinforcement fibers.

(28) The outer member **31** is, like the cylindrical member **41**, formed with the fiber-reinforced resin where carbon fibers are impregnated with the thermoplastic resin or the thermosetting resin. The carbon fibers may include fibers oriented in the axial direction and those oriented in a direction crossing the axial direction at an appropriate ratio. However, orientation directions of the carbon fibers may be one direction or different directions. Furthermore, the outer member **31** may contain short fibers other than continuous fibers and may contain fibers other than carbon fibers as reinforcement fibers.

(29) As illustrated in FIG. 3, the outer member **31** of the center pillar **3** according to the present embodiment is formed to have a hat cross-section and the cylindrical member **41** is disposed in a recess region between the flanges **31a**, **31b** on both sides in the vehicle longitudinal direction. At least a bottom surface of the recess region of the outer member **31** is bonded to the outer surface of the cylindrical member **41**.

(30) The inner member **21** includes a base material **23** and filling parts **29a**, **29b**, **29c** (hereinafter, collectively referred to as “filling parts **29**” unless the members are distinguished from each other). The base material **23** is formed from the fiber-reinforced resin where carbon fibers are impregnated with the thermoplastic resin or the thermosetting resin. The carbon fibers may include fibers oriented in the axial direction and those oriented in a direction crossing the axial direction at an appropriate ratio. However, orientation directions of the carbon fibers may be one direction or different directions. Furthermore, the inner member **21** also may contain short fibers other than continuous fibers and may contain fibers other than carbon fibers as reinforcement fibers.

(31) As illustrated in FIG. 3, the base material **23** of the inner member **21** has multiple recessed grooves **27a**, **27b**, **27c** (hereinafter, collectively referred to as “recessed grooves **27**” unless the grooves are distinguished from each other) provided on a surface of the inner member **21** closer to

the cylindrical member **41**, recessed in a direction away from the cylindrical member **41**, and extending along the axial direction of the cylindrical member **41**. In the example illustrated in FIG. **3**, the base material **23** has the three recessed grooves **27a**, **27b**, **27c**. Since the base material **23** has the multiple recessed grooves **27**, a section modulus of the base material **23** increases and the rigidity against a bending moment acting during the input of the collision load of the side collision can be improved.

(32) The filling parts **29** are disposed in the recessed grooves **27**, respectively. The filling parts **29** are each configured with a fiber-reinforced resin containing continuous fibers wound around pin members **25u**, **25d** provided on axially both sides of each recessed groove **27** and oriented along the axial direction (refer to FIG. **4**). The pin members **25u**, **25d** are rod members made of a metal such as iron or aluminum and secured to the base material **23**. The pin members **25u**, **25d** may be any material that does not deform even by a heat treatment in processes of forming the inner member **21** and are not limited to the metal members.

(33) Such filling parts **29** can be formed using, for example, a tailored fiber placement (TFP) method. At this time, a position (height) of a surface of the fiber-reinforced resin filled in each recessed groove **27** is desirably identical to a position (height) of an edge of the recessed groove **27** so that a uniform surface of the inner member **21** facing the cylindrical member **41** can be provided without height differences. It is thereby possible to make uniform the bonded surface of the inner member **21** bonded to the cylindrical member **41**, increase a bonding area, and prevent a reduction in the bonding strength.

(34) A breaking strain of the filling parts **29** is designed higher than a breaking strain of the CFRP configuring the inner member **21**. For example, by using the fibers higher in coefficient of strain than carbon fibers as the continuous fibers configuring the filling parts **29**, it is possible to design the breaking strain of the filling parts **29** higher than the breaking strain of the CFRP. While examples of such fibers include a mixture of each or one of glass fibers and aramid fibers, other fibers may be used. By using the resin higher in coefficient of strain than the CFRP as the resin configuring the filling parts **29**, it is possible to design the breaking strain of the filling parts **29** higher than the breaking strain of the CFRP. While examples of such a resin include a mixture containing polyphenylene ether (PPE) resin, the other resin may be used.

(35) The higher breaking strain of the filling parts **29** than that of the CFRP can reduce the risk of breaking the inner member **21** serving to receive the load during the input of the collision load of the side collision. It is, therefore, possible to produce an effect of absorbing the collision energy and securing safety in the vehicle cabin.

(36) Furthermore, in the present embodiment, the pin members **25u**, **25d** of the inner member **21** may be used as part of a coupling structure coupling the center pillar (vehicle body pillar structure) **3** to a vehicle body structural member. In an example, the pin member **25u** provided on a top of the center pillar **3** may be used as part of a coupling structure coupling the center pillar **3** to the roof pillar **5**, and the pin member **25d** provided on a bottom of the center pillar **3** may be used as part of a coupling structure coupling the center pillar **3** to the side sill **6**.

(37) FIG. **5** illustrates a configuration example of using the pin member **25d** on the bottom of the center pillar **3** as part of the coupling structure coupling the center pillar **3** to the side sill **6**. FIG. **5** illustrates a state of coupling the bottom of the center pillar **3** corresponding to the cross-sectional view illustrated at the right in FIG. **2** to the side sill **6**.

(38) The pin member **25d** penetrates the base material **23** of the inner member **21**, and one axial end of the pin member **25d** is exposed to an outside of the inner member **21**. The pin member **25d** has a bolt hole **26** formed along a shaft core and opened to both axial ends of the pin member **25d**. A coupling bolt **28** serving as a coupling member that couples the center pillar **3** to the side sill **6** is inserted into the bolt hole **26**. In addition, a bolt hole **7** is formed in the side sill **6** and the coupling bolt **28** is also inserted into the bolt hole **7**. Therefore, the center pillar **3** is coupled to the side sill **6** by inserting the coupling bolt **28** into the bolt hole **26** of the pin member **25d** and the bolt hole **7** of

the side sill **6** and fastening the coupling bolt **28**.

(39) Although not illustrated, the pin member **25u** provided on the top of the center pillar **3** is configured similarly to the pin member **25d** and used as part of a coupling structure coupling the center pillar **3** to the roof pillar **5**. In this way, the pin members **25u**, **25d** are used as part of the coupling structure coupling the center pillar **3** to the roof pillar **5** or the side sill **6**. This makes it unnecessary to separately provide configurations for positioning the center pillar **3** relative to the roof pillar **5** or the side sill **6** and the coupling member coupling the center pillar **3** to the roof pillar **5** or the side sill **6**.

(40) Subsequently, an example of a method of manufacturing the center pillar **3** according to the present embodiment and a method of forming the inner member **21** using the TFP method will be described.

(41) First, a well-known method such as a braiding method, a filament winding method, a sheet winding method, a lay-up method, a cold pressing forming method, or a hot pressing forming method is used to form the outer member **31** and the cylindrical member **41**. The forming method of the outer member **31** and the cylindrical member **41** is not limited to a specific method.

(42) In addition, CFRP prepregs are stacked using a forming die or the like to form a semi-molten intermediate base material corresponding to the base material **23** and having the multiple recessed grooves **27**. At this time, the pin members **25u**, **25d** are provided on both axial sides of the recessed grooves **27**. In a case of the inner member **21** illustrated in FIG. **4**, the pin members **25u**, **25d** are provided with the axial direction made to match a thickness direction of the intermediate base material. The pin members **25u**, **25d** may be installed in advance when the intermediate base material is formed or may be disposed after the intermediate base material is formed. A forming method of the intermediate base material is not limited to a specific method.

(43) Next, continuous fibers are wound around the two pin members **25u**, **25d** with respect to the recessed grooves **27** and fiber bundles are placed in the recessed grooves **27**, respectively. Furthermore, the fiber bundles are fixedly sewn to the intermediate base material. A process of placing the fiber bundles and sewing the fiber bundles to the intermediate base material is carried out using the TFP method.

(44) Next, the resin is poured into each recessed groove **27** where the fiber bundle is disposed to form the fiber-reinforced resin made from the fiber bundle and the resin in the recessed groove **27**. The fiber-reinforced resin in the recessed groove **27** is then cured together with the intermediate base material, thus forming the inner member **21** having the filling part **29** in each recessed groove **27**.

(45) Next, the inner member **21** and the outer member **31** are bonded to the cylindrical member **41** with the adhesive or the like, and the center pillar **3** according to the embodiment can be thus obtained.

(46) In the center pillar **3** according to the present embodiment, the inner member **21** has the multiple recessed grooves **27** extending along the axial direction. Therefore, the section modulus of the base material **23** increases and the rigidity against the bending moment acting during the input of the collision load of the side collision can be improved. Furthermore, the filling parts **29** formed from the fiber-reinforced resin including the continuous fibers disposed along the axial direction and having the breaking strain higher than the breaking strain of the CFRP are disposed in the recessed grooves **27** of the inner member **21**, respectively. Owing to this, it is possible to reduce the risk of breaking the inner member **21** serving to receive the load during the input of the collision load of the side collision and produce the effect of absorbing the collision energy and securing safety in the vehicle cabin.

(47) Moreover, in the center pillar **3** according to the present embodiment, the position (height) of each of the filling parts **29** filled in each of the recessed grooves **27** of the inner member **21** are made identical to the position (height) of the edge of the recessed groove **27**. In addition, the uniform surface of the inner member **21** facing the cylindrical member **41** is provided without



height differences. It is thereby possible to make uniform the bonded surface of the inner member **21** bonded to the cylindrical member **41**, increase a bonding area, and prevent a reduction in the bonding strength.

(48) Furthermore, the center pillar **3** according to the present embodiment is configured with the inner member **21**, the outer member **31**, and the cylindrical member **41**, and the inner member **21** and the outer member **31** are bonded to surround the cylindrical member **41**. Thus, the center pillar **3** having the cylindrical closed cross-section is structured, which can maintain the continuity of the reinforcement fibers in whichever direction, the axial direction or the circumferential direction. Therefore, the center pillar **3** capable of effectively exerting strength characteristics of the fiber-reinforced resin can be obtained.

(49) Furthermore, in the center pillar **3** according to the present embodiment, the pin members **25u**, **25d** used when forming the filling parts **29** disposed in the recessed grooves **27** of the inner member **21** can be used part of the coupling structures coupling the center pillar **3** to the roof pillar **5** and the side sill **6**. For this reason, the configurations for positioning the center pillar **3** with respect to the roof pillar **5** and the side sill **6** and the coupling member for coupling the center pillar **3** to the roof pillar **5** or the side sill **6** may not be provided separately.

(50) While the embodiment of the technique of the disclosure has been described in detail with reference to the accompanying drawings, the disclosure is not limited to the embodiment. It is evident that a person having ordinary skill in the art to which the disclosure pertains could conceive of examples of various modifications or revisions within the scope of the technical concept set forth in the claims. It would be understood that these modifications or revisions naturally fall in the technical range of the disclosure. Furthermore, modes of combinations of the embodiment with the modifications naturally fall in the technical scope of the disclosure.

(51) As described so far, according to the technique of the disclosure, it is possible to obtain the vehicle body center pillar structures capable of maintaining the bonding strength for bonding the cylindrical member to the outer layer member of the CFRP pillar and having the high rigidity against the collision load of the side collision.

## Claims

1. A vehicle body pillar structure comprising: a cylindrical member formed from a carbon fiber-reinforced resin; and an outer layer member provided on an outer circumference of the cylindrical member and formed from a carbon fiber-reinforced resin, wherein the outer layer member comprises a recessed groove provided on a surface of the outer layer member closer to the cylindrical member, recessed in a direction away from the cylindrical member, and extending along an axial direction of the cylindrical member, and a fiber-reinforced resin is disposed in the recessed groove, the fiber-reinforced resin containing continuous fibers wound around pin members provided on both axial sides of the recessed groove and being oriented along the axial direction of the cylindrical member.
2. The vehicle body pillar structure according to claim 1, wherein the pin members are used as part of a coupling structure configured to couple the vehicle body pillar structure to a vehicle body structural member.
3. The vehicle body pillar structure according to claim 2, wherein the pin members each have a bolt hole or comprise a coupling member, the bolt hole or the coupling member being configured to couple the vehicle body pillar structure to the vehicle body structural member.
4. The vehicle body pillar structure according to claim 1, wherein the continuous fibers of the fiber-reinforced resin filled in the recessed groove comprise fibers different from carbon fibers.
5. A vehicle body structure comprising a vehicle body pillar structure comprising: a cylindrical member formed from a carbon fiber-reinforced resin; and an outer layer member provided on an outer circumference of the cylindrical member and formed from a carbon fiber-reinforced resin,

wherein the outer layer member comprises a recessed groove provided on a surface of the outer layer member closer to the cylindrical member, recessed in a direction away from the cylindrical member, and extending along an axial direction of the cylindrical member, and a fiber-reinforced resin is disposed in the recessed groove, the fiber-reinforced resin containing continuous fibers wound around pin members provided on both axial sides of the recessed groove and being oriented along the axial direction of the cylindrical member.

---