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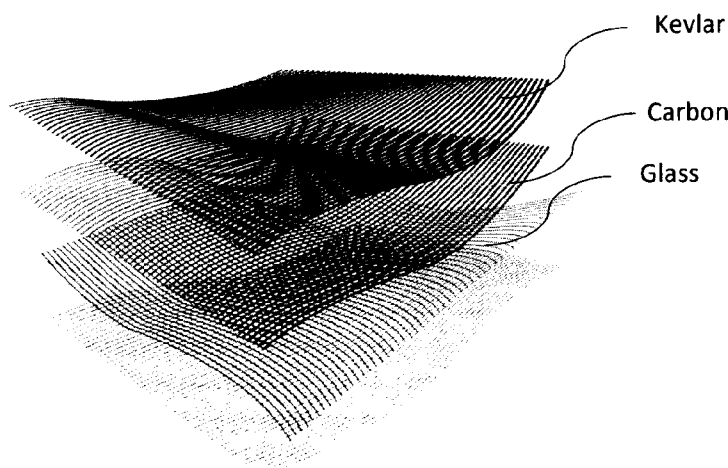


FIG. 3A

(57) Abstract: In one embodiment there is disclosed a vehicle monocoque body formed without a chassis, comprising: a support surface (10) having a front end and a rear end; and is adapted for providing a base for the vehicle and for direct coupling of axles for attachment of wheels; a top surface (11) adapted as a roof for the vehicle; opposing lateral surfaces (12,14) extending upwardly from the support surface (10); a front surface (16) extending upwardly from the front end of the support surface (10) and; a rear surface (18) extending upwardly from the rear end of the support surface (10). The support surface (10), the top surface (11), the opposing lateral surfaces (12,14), the front and rear surfaces (16,18) are formed from a composite material comprising a combination of least two materials comprising of kevlar, carbon and glass fibre materials; whereby the surfaces are joined together to form the vehicle monocoque body (1).





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VEHICLE MONOCOQUE BODY AND METHOD OF MANUFACTURING THEREOF

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FIELD OF INVENTION

[0001] The present invention generally relates to road vehicles; and more particularly to a vehicle having a carrying capacity of at least 10 tonnes and above.

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BACKGROUND ART

[0002] A vehicle comprises multiple moving parts which are supported by a skeletal structure or a frame, whereby the frame is accordingly adapted in a manner such that it can accommodate the body of the vehicle and plurality of components to operate the vehicle. The method of assembling the vehicle body to the skeletal structure or frame is generally known as body-on-frame approach. A body-on-frame structure denotes two entities, one being the body of the vehicle and secondly the frame on which the body of the vehicle is mounted.

[0003] Existing body-on-frame structures are typically constructed from metal-based materials or composite; hence can technically result to substantial amount of weight. Albeit being widely preferred for its durability; the structure suffers from numerous limitations; such as prohibitively costly materials and manufacturing costs; high fuel consumption especially for heavy-duty vehicles; and being substantially heavy which can result to low operational performance.

[0004] Such limitations have been addressed partially, with the introduction of unibody construction. In contrast to that of the body-on-frame construction, the unibody construction enables the body and frame to be formed as a single unit, with reinforcements at specific zones. At present, the unibody assembling approach is gaining momentum and has been largely replacing the conventional body-on-frame construction owing to its minimalism, lower manufacturing cost and higher performance. Unibody structures, also known as monocoque, are constructed significantly lighter than body-on-frame structures, which thereby translates to

improved performance and fuel economy. The essence of unibody construction is to form a structure that can accommodate any given load by means of its external skin, which is why currently the monocoque structure is extensively favoured amongst high-performance cars for its lightweight, structural integrity and being stable at high speeds.

5 Nevertheless, the concept of using the monocoque structure for heavy-duty vehicles such as buses, trucks and so forth is still at an introductory level with minimal impact, as commonly the body-on-frame structure is perceived to have better strength to accommodate loads or carrying capacity for these heavy-duty type of vehicles. As a result, in many cases, to obtain a monocoque structure that can withstand the types of

10 loads associated to heavy-duty vehicles, metal members have been used as reinforcements, primarily to provide the desired strength.

[0005] Therefore, there is a great need in the prior art for a monocoque body or structure that can effectively address the glaring drawbacks as discussed above, and

15 formed with a lightweight, core structure to achieve the required strength profile devoid of substantially weighty reinforcement elements.

SUMMARY OF INVENTION

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[0006] An aspect of the present invention is a vehicle monocoque body without a chassis, comprising: a support surface having a front end and a rear end; and is adapted for providing a base for the vehicle and for direct mounting of wheels; a top surface adapted as a roof for the vehicle; opposing lateral surfaces extending upwardly from

25 the support surface; a front surface extending upwardly from the front end of the support surface and; a rear surface extending upwardly from the rear end of the support surface; characterised in that; the support surface, the top surface, the opposing lateral surfaces, the front and rear surfaces are formed from a composite material comprising a combination of kevlar, carbon and glass fibre materials; whereby the surfaces are

30 joined together to form the vehicle monocoque body.

[0007] In a preferred embodiment, the surfaces are formed based on variable thicknesses to accommodate variable loads.

[0008] In yet another preferred embodiment, the body is formed with the composite material such that the load of the vehicle is spread proportionately across the vehicle monocoque body.

5 [0009] In a further preferred embodiment, the composite material further includes a filler material for filling in at least one gap between the kevlar, carbon and glass fibre materials to increase the load bearing capacity without increasing the overall weight. In an example, the filler material is foam.

10 [0010] In another preferred embodiment, the combination of at least two of kevlar, carbon and glass fibre materials is adapted as skin layers for the composite material.

[0011] In yet a further embodiment, the filler material forms the core layer for the composite material; hence sandwiched between the skin layers of the composite material.
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[0012] Another aspect of the present invention is a method of fabricating a composite material to be used in constructing a monocoque body of a vehicle comprising: providing at least two skin layers formed from a combination of at kevlar, carbon and
20 glass fibre materials; wherein the kevlar, carbon and glass fibre materials are prepared in a manner such that they are structured in differing orientations and form a matrix structure; providing a filler material as a core layer arranging the layers in a manner such that the skin layers are sandwiching the core layer; and bonding the layers together to form the composite material.

25 [0013] In a preferred embodiment, the layers includes subjecting the layers to resin impregnation process and a curing process thereafter.

[0014] In one aspect, there is provided a composite material formed from kevlar,
30 carbon and glass fibre materials to construct a vehicle body.

[0015] Another aspect is a method of manufacturing a vehicle having a carrying capacity of 10 tonnes and above, comprising: preparing a composite material from kevlar, carbon and fibre glass materials; forming a vehicle body based on the composite
35 material; and securing a plurality of axles to the vehicle body for attachment of wheels.

BRIEF DESCRIPTION OF DRAWINGS

5 [0016] The present invention features, objects and advantages thereof may be best understood by reference to the following detailed description when read with accompanying drawings in which:

10 [0017] **FIG. 1A** and **FIG. 1B** illustrates an overall view of the vehicle body in accordance with an embodiment of the present invention;

[0018] **FIG. 2** illustrates an overall process flow in fabricating the composite material in accordance with an embodiment of the present invention;

15 [0019] **FIG. 3A** illustrates an arrangement of the kevlar, carbon and glass fibre materials of the composite in accordance with an embodiment of the present invention;

[0020] **FIG. 4** illustrates the skin layers sandwiching the core layer of the composite in accordance with an embodiment of the present invention;

20 [0021] **FIG. 5A** and **FIG. 5B** illustrate examples of front and rear axle set that can be used for the vehicle body in accordance with an embodiment of the present invention.

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DETAILED DESCRIPTION

30 [0022] In line with the above summary, the following description of a number of specific and alternative embodiments is provided to understand the inventive features of the present invention. It shall be apparent to one skilled in the art, however that this invention may be practiced without such specific details. Some of the details may not be described at length so as not to obscure the invention. For ease of reference, common reference numerals will be used throughout the figures when referring to the same or similar features common to the drawings.

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[0023] In accordance to the embodiments of the present invention there is provided a vehicle monocoque body, eliminating the chassis as a separate structure; adapted and enabled for withstanding of at least 10 tonnes of load. In one embodiment, the present invention is a monocoque body without a base chassis for a commercial passenger and load carrying electrical vehicle, and more particularly for an electrical bus. It is however anticipated that the monocoque body fabricated and constructed in accordance with the embodiments of the present invention can be applicable to other types of road vehicle. With reference to **FIG. 1A** and **FIG. 1B**, the monocoque vehicle body **1** in accordance with an embodiment of the present invention comprises a support surface **10**, a top surface **11**, opposing lateral surfaces **12, 14**, front surface **16** and rear surface **18**. The opposing lateral surfaces **12, 14**, front and rear surfaces **16, 18** are extending vertically from the support surface **10**.

[0024] The method for forming these surfaces in accordance with the embodiments of the present invention is not particularly limited, but these surfaces are constructed from a composite material, linked together as a unitary structure, or referred herein as unibody vehicle structure. The composite material that is used to construct the surfaces thereby the vehicle monocoque body in accordance with the present invention will be described in much greater detail in the succeeding paragraphs. It is also understood that there are many ways of implementing the linking or connecting the surfaces to form the unitary body; using different conventional or standard technologies. The surfaces may be constructed separately as sub-segments or sub-assemblies and then secured together or in its entirety as a vehicle body, by way of; but not limiting to; injection-molding. The composite composition of each surface or parts of the vehicle monocoque body according to the embodiments of the present invention is customised based on Finite Element Analysis (FEA); at which with the output of the analysis, the properties or characteristics, including the strength for each surface or as a whole body required for varying load requirements, can be determined. The unitary monocoque vehicle body in accordance with the embodiments of the present invention takes the form of the composite material and may be formed through a single-step molding process; or any conventional unitary molding principles or processes that results to a final shape or configuration as clearly illustrated in the drawing figures.

[0025] The composite material in accordance with an embodiment of the present invention comprises multiple layers of materials being held in place or laminated in a manner such that there is no transverse load on the fibres. The composite comprises at least one type or a combination of; fibre glass, kevlar fibre and carbon fibre materials, all integrated or fabricated into a composite material. These materials may be laminated or held together by means of resin impregnation, followed by a curing process to obtain its final form.

[0026] An exemplary method to fabricate the composite in accordance with an embodiment of the present invention will now be described with reference to FIG. 2. A skin layer or sheet is prepared from at least one or a combination of kevlar, carbon and glass fibre materials at S201; , and then structured such that they are applied on top of each other or structured with differing orientations hence forming a matrix structure at S202. It should be noted that the layer of materials are held together via any standard or conventional technique, for example, stitch-bonding. Each combination of kevlar, carbon and glass fibre bonded sheets is adapted to form a skin layer of the composite. Next at S203, a core layer is prepared from a foam material, with a predetermined thickness. The bonded materials are then arranged in a manner such they sandwich the foam core layer at S204. In this arrangement, there may be two sets of bonded sheets being the skin layers, sandwiching the foam core layer. The formed sandwich is then subjected to a resin impregnation process at S205, which can be performed by means of vacuum assisted resin transfer moulding (VARTM) technique. Generally, with VARTM process, air and liquid resin are driven out from the materials by placing the bonded materials under vacuum conditions. As a result, the air gaps between the layers can be reduced and provide a strong and well-bonded composite.

[0027] It should be noted that the fibre glass and carbon materials in the composite material may be of organic or inorganic fibers, whereby non-limiting examples of fibers that may be utilized in to form the composite material include glass fibers, wool glass fibers, natural fibers, mineral fibers, graphite fibers, nanofibers, or combinations thereof. In one embodiment, materials of the composite may be functionalised by chemical elements or prepared in combination with other compounds, or with other materials such as polycarbonate or any thermoplastic durable

materials, whereby these materials may originally prepared as flakes, granule, or a powder prior to being formed into sheets. The kevlar material used in the present invention may of any type of kevlar materials; or any polymerised plastic materials that can serve and deliver the results as intended in accordance with the embodiments of the present invention.

[0028] The thickness of the composite material may vary depending on the desired load bearing capacity of the vehicle. It is fabricated to be lightweight and can be manufactured in a cost-effective manner. Each material layer of the composite is applied in varying arrangements such that metal reinforcements can be avoided; and in a manner such that the final form is a durable matrix structure that is elastically deformable. Examples of potential positioning or arrangement of layers to form the composite material of the present invention are illustrated in **FIG. 3A** and **FIG. 3B**.

[0029] With reference to **FIG. 3B**, in one embodiment, the layers are applied on top of each other, or structured in multiple orientations, such that they form a multidirectional composite, at predetermined angles with differing axial directions. In one embodiment, the layers may be bonded at predetermined bonding points. Now referring to **FIG. 4**, in a preferred fabrication, the foam material as discussed in the preceding paragraphs serves as a spacer thereby core material in between the two layers of either kevlar, carbon or fibre glass layers; or a combination thereof. Still referring to **FIG. 4**, it is evident that, in another possible arrangement, as a result to the multi-oriented or multidirectional layers of the fibres, the arrangement emulates an "I" beam geometry thereby providing additional strength to the composite without additional weight.

[0030] In one embodiment, using a lightweight material such as foam as a core layer thereby as a filler material to provide a gap in between the layers of kevlar, carbon and glass fibres of the composite material; aids to increase the load bearing capacity without increasing the weight of the vehicle body; by providing a gap between the skin layers allowing proportional load spread of the vehicle body 1.

[0031] It is understood that there may be other types of filler materials aside from foam used to form the gap between the layers of the composite in addition to at least a combination of kevlar and glass fibre. Carbon is an optional material to provide sufficient strength to the composite. In a preferred embodiment, the gap distance

between the skin layers varies; in which the increase of gap distance increases the strength of the composite.

[0032] Still referring to **FIG. 1**, the support surface **10** is generally adapted to form a floor structure or base portion of the vehicle and comprises wheel and axle interfaces **10a**, **10b**. In this embodiment, the support surface **10** functions as a chassis, hence eliminating the prerequisite of a chassis for mounting of wheels to the vehicle body. The support surface **10** comprises a rear end and a front end, whereby both the front and rear ends of the support surface **10** are adapted accordingly to receive the front and rear surfaces **16**, **18**. In one embodiment, the wheel and axle interfaces **10a** may include recesses accordingly and uniformly sized to serve as wheel wells and receive the front and rear wheels and axles of the vehicle. With the presence of the recesses there may be a plurality of raised portions **10c** from the support surface **10**. The support surface **10** is formed with a predetermined dimension, and can be generally rectangular, sufficiently sized to at least accommodate electrical components. It is anticipated that there is no geometrical limitation for the support surface **10** in accordance with an embodiment of the present invention; and is adapted to include or accommodate other conventional components required for the operational effect of the vehicle. The support surface **10** may further include compartments or stowage spaces.

[0033] In one embodiment, the support surface **10** is further adapted to accommodate means for attaching the axle for the wheels and suspension assembly to the monocoque vehicle body **1**; whereby each axle set is directly coupled to the underside of the support surface **10**, such that the wheels are disposed within the recesses of the wheel and axle interfaces **10a**, to support and provide mobility for the monocoque body of the vehicle **1**. With the monocoque body constructed with the present invention, the wheel set can be directly mounted to the support surface **10** without the interposition of a frame or additional mounting surface. Fastening means including bolts or the like can be used to secure the wheel and axle set to the support surface **10**. This arrangement may be used for each axle set for the vehicle.

[0034] With reference to **FIG. 5A** and **FIG. 5B**, the axle set may include axle support means **13** for attachment to the support surface **10** of the vehicle body. An example of the front axle set is as illustrated in **FIG. 5A**. The axle support means **13** for the front

axle may include fixture **131** with fastening or coupling means **132** adapted for attaching the fixture **131** to the support surface **10**. The fixture **131** may include a triangular rib having multiple portions accordingly adapted to be attached to the wheels and a pair of joint means **133** to the vehicle body **1**.

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[0035] Referring to **FIG.5B**, in one example for the rear axle set, the axle support means may include a hollow body **134** for which the axle can extend through; and at least two set of arms **135**, extending from the body **134**. The support means is adapted for removable attachment to the underside of the support surface **10**. The free end of each arm may be adapted to include fastening or coupling means for securing to the support surface **10**. The steering bevel gear mechanism may be directly secured to the vehicle body **1** by suitable coupling means as shown in **FIG.6**.

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[0036] The top surface **11** is generally adapted to form the roof of the vehicle body **1**, accordingly sized to match that of the support surface **10**, and for attachment to one end of the opposing lateral surfaces **12**, **14**. The top surface **11** is further accordingly adapted for mounting or installation of rooftop conditioning means, to provide conditional air within the interior of the vehicle. In contrast to that of conventional roof surface of a vehicle whereby the mounting surface is separate from the roof, the top surface **11** of the present invention is constructed with the composite material such that it forms both the mounting surface for the conditioning means and the roof the vehicle. Such feature eliminates the requirement of a frame for mounting or installing air conditioning means, resulting to a significant weight reduction from the overall weight or load to be supported by the vehicle body **1**.

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[0037] The lateral surfaces **12**, **14** is generally adapted to form the side walls or frames of the vehicle body, whereby each lateral surface **12**, **14** extends vertically from the support surface **10**. In one embodiment, the lateral surfaces **12**, **14** are contiguously attached to the support surface **10**. The lateral surfaces **12**, **14** are formed with plurality of cut-out portions **12a**, **14a**; the cut-out portions are accordingly sized and adapted as windows or doors for the vehicle. The lateral surfaces **12**, **14** are formed generally symmetrical to each other and disposed at opposing locations; relative to the support surface **10**.

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[0038] The front and rear surfaces **16**, **18** are adapted such that they extend upwardly from the support surface **10**. The front surface **16** is accordingly sized to match that of the rear surface **18**, and both having a width that preferably matches that of the support surface **10**. Both of the front and rear surfaces **16**, **18** may be adapted to accommodate or equipped with attachment portions or spaces for enabling mounting or engagement of removable bumpers, impact absorbers, or members of the likes. In an embodiment, the front surface **16** may be constructed such that it includes at least one opening sufficiently sized such that it can be adapted as a windshield for the vehicle, and the same can be provided for the rear surface **18**.

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[0039] It is further understood that the surfaces of the vehicle body **1** may be manufactured in different sizes and thicknesses to cater for different load bearing capacity. Understandably, the dimensions for the surfaces and the overall vehicle body **1** in accordance to the embodiments of the present invention may vary. The exact shape of the vehicle including their contours, aspect ratios, thicknesses, angle of inclination of any of the surfaces and any other parameters that define the shape may differ from one implementation to another to suit the different requirements of the vehicle. It is understood optimising the exact shape and load capacity of the monocoque body for the vehicle includes the use of modern software in determining and verifying the overall vehicle performance.

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[0040] By virtue of customizable surfaces sizes, shapes and dimension in relation to the vehicle body **1**, the structure can be adapted or designed for specific loads while maintaining the lightweight principle. In an embodiment, with the flexibility of the composite material to construct the monocoque vehicle body, the structure can be adapted to be reinforced by adjusting the parameters of the composite, such as; but not limiting to increasing the thickness of composite; or allowing some portions of the vehicle body **1** to be stronger or weak at other areas. The latter optimises the vehicle's safety features and designs by not compromising overall body rigidity thereby creating a dynamic crash response characteristics, compared to that of the conventional vehicles.

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[0041] And it is also understood that the complete electric vehicle will include the main electronic control system which controls the vehicle and perform supervisory and

protection functions. The main electronic control system may be configured and expanded to communicate with and supply power to the wheels of the vehicle constructed in accordance with the present invention to realise the full functionality of the present invention.

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[0042] Although the embodiments of the present invention have been described, it would be appreciated that the present invention may be modified in light of the above teachings. It is therefore understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

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CLAIMS:

1. A vehicle monocoque body (1) without a chassis, comprising:
- 5 a support surface (10) having a front end and a rear end; and is adapted for providing a base for the vehicle and for direct coupling of axles for attachment of wheels;
- 10 a top surface (11) adapted as a roof for the vehicle;
- opposing lateral surfaces (12,14) extending upwardly from the support surface (10);
- a front surface (16) extending upwardly from the front end of the support surface (10) and;
- 15 a rear surface (18) extending upwardly from the rear end of the support surface (10);
- characterised in that;
- 20 the support surface (10), the top surface (11), the opposing lateral surfaces (12,14), the front and rear surfaces (16,18) are formed from a composite material comprising a combination of kevlar, ~~carbon~~ and glass fibre materials; whereby the surfaces are joined together to form the vehicle monocoque body (1).
- 25 2. The vehicle monocoque body (1) as claimed in Claim 1, wherein the composite further comprises Carbon material.
3. The vehicle monocoque body (1) as claimed in Claim 1, wherein the surfaces are formed based on variable thicknesses to accommodate variable loads.
- 30 4. The vehicle monocoque body (1) as claimed in Claim 1, wherein the body is formed with the composite material such that the load of the vehicle is spread proportionately across the vehicle monocoque body (1).

5. The vehicle monocoque body (1) as claimed in Claim 1, wherein the composite material further includes a filler material to provide at least one gap between the kevlar, carbon or glass fibre materials to increase the load bearing capacity without increasing the overall weight.

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6. The vehicle monocoque body (1) as claimed in Claim 1, wherein the filler material is a foam layer to provide a gap between the kevlar, carbon or glass fibre material to increase the load bearing capacity of the vehicle.

10 7. The vehicle monocoque body (1) as claimed in Claim 1, wherein the combination of at least two of the materials comprising: kevlar, carbon and glass fibre materials is adapted as skin layers for the composite material.

8. The vehicle monocoque body (1) as claimed in Claim 2, wherein the foam material forms the core layer for the composite material; hence sandwiched between the skin layers of the composite material.

15 9. The vehicle monocoque body (1) as claimed in Claim 1, wherein the axle further includes an axle support means.

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10. The vehicle monocoque body (1) as claimed in Claim 1, wherein the vehicle is a bus powered by electrical motors.

25 11. A method of fabricating a composite material to be used in constructing a monocoque body of a vehicle comprising:

providing at least two skin layers formed from a combination of at least two materials from a group of materials comprising: kevlar, carbon and glass fibre materials; wherein the kevlar, carbon and glass fibre materials are prepared in a manner such that they form a matrix structure;

30 providing a filler material to form a gap between the skin layers;
arranging the layers in a manner such that the skin layers are sandwiching the filler material;

35 bonding the layers together to form the composite material.

12. The method as claimed in Claim 9, wherein bonding the layers includes subjecting the layers to resin impregnation process and a curing process thereafter.

5 13. A method of manufacturing a vehicle having a carrying capacity of 10 tonnes and above, comprising:

preparing a composite material from a combination of at least two materials from a group comprising: kevlar, carbon and fibre glass materials;

10 forming a vehicle body based on the composite material; and

securing a plurality of axles to the vehicle body for attachment of wheels.

14. Using the composite material as claimed in Claim 1 to construct a vehicle body.

15 15. The method as claimed in Claim 1, wherein the vehicle is a bus powered by electrical motors.

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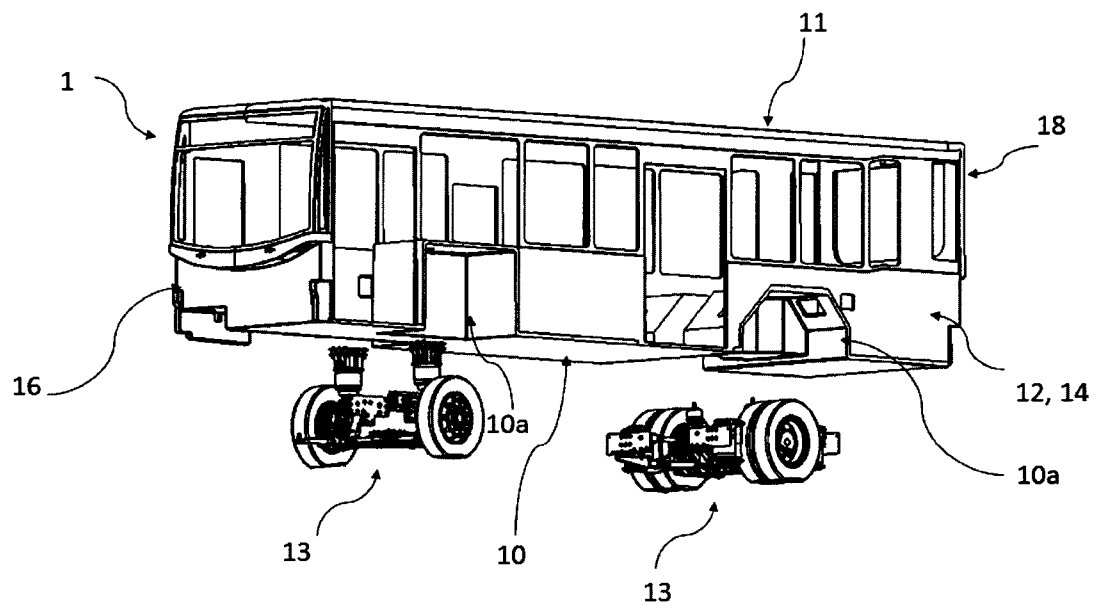


FIG. 1A

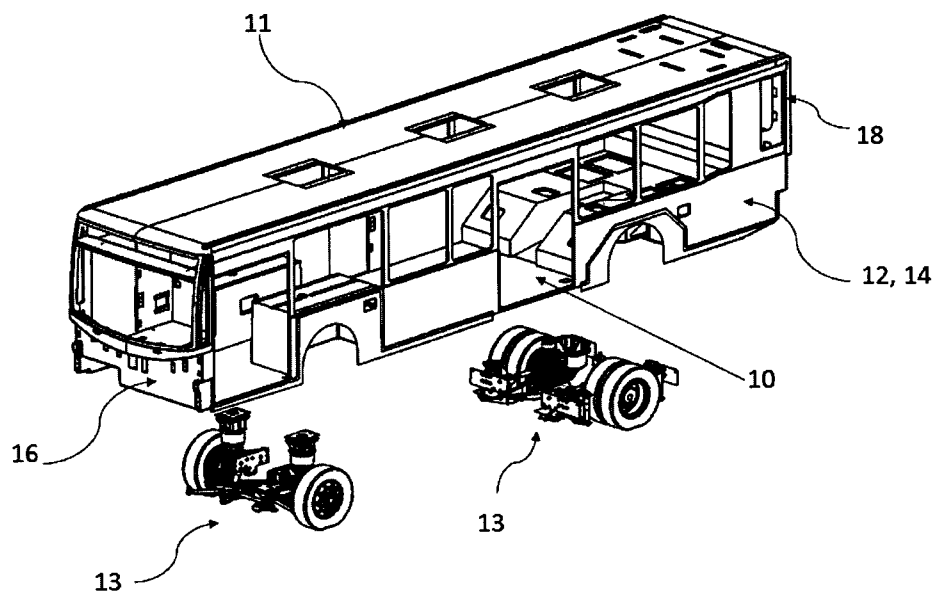
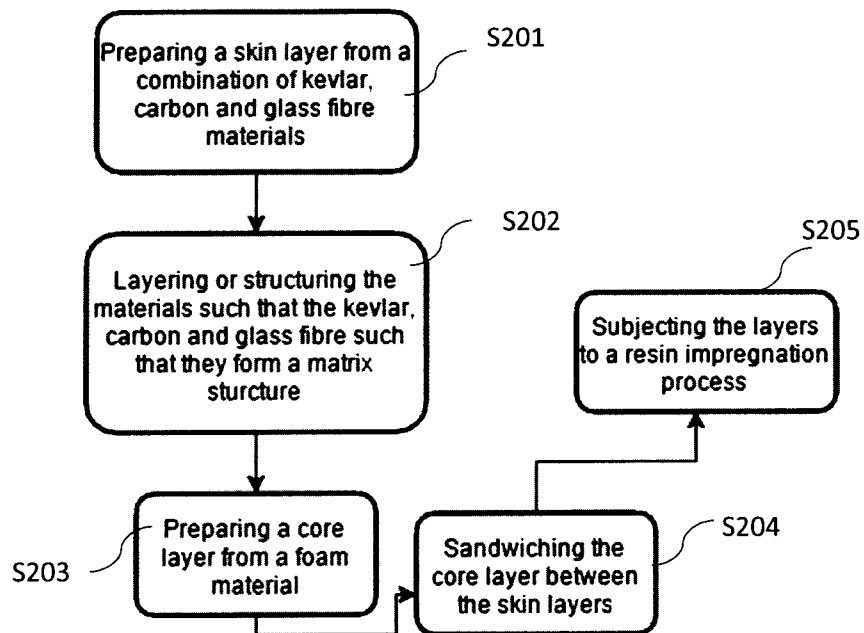
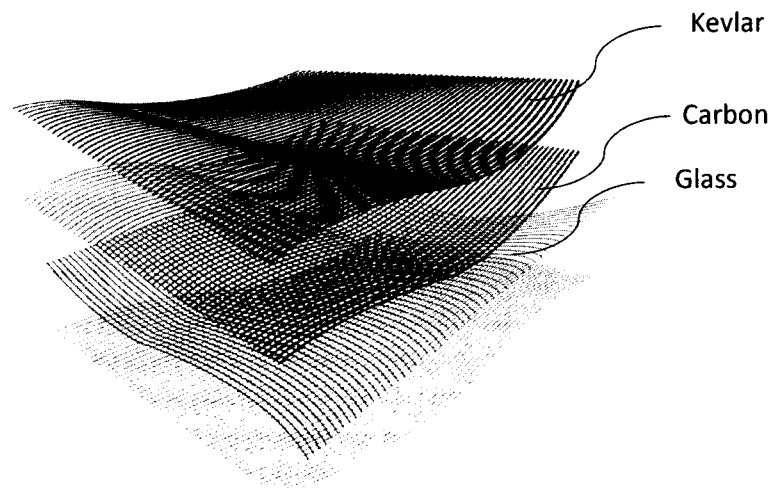


FIG. 1B

**FIG. 2****FIG. 3A**

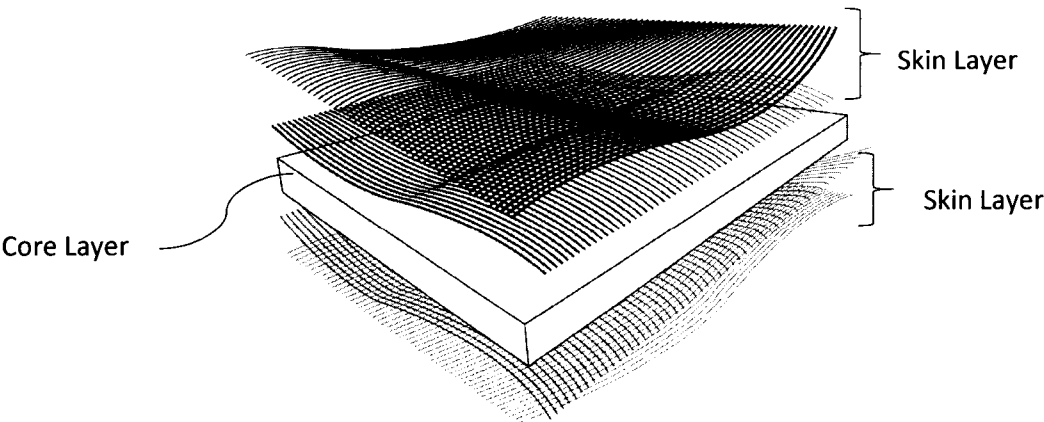


FIG. 3B

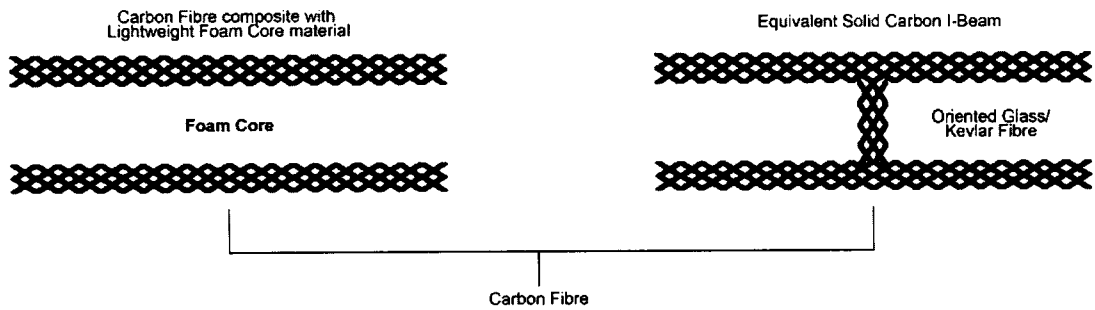


FIG. 4

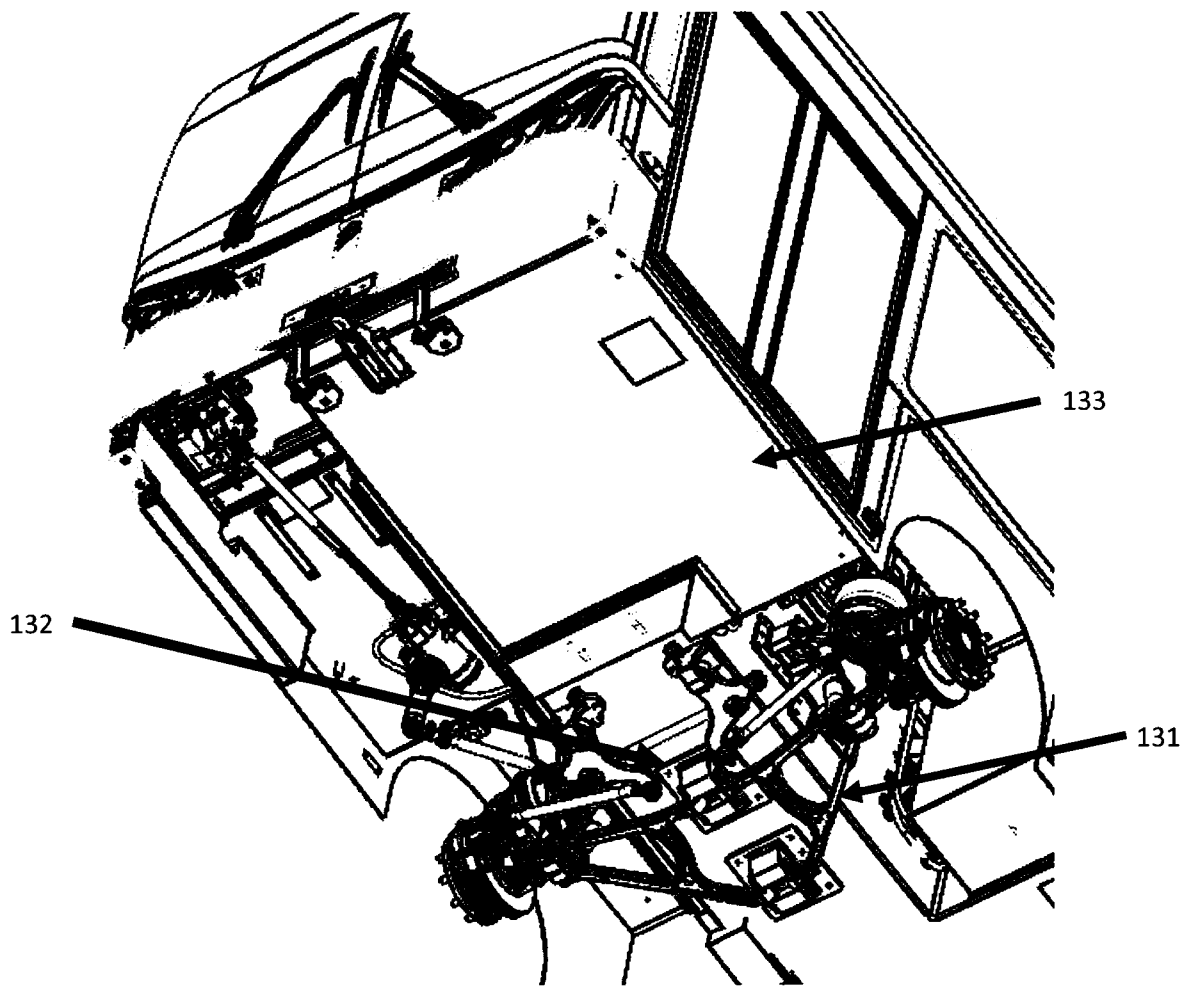


FIG. 5A

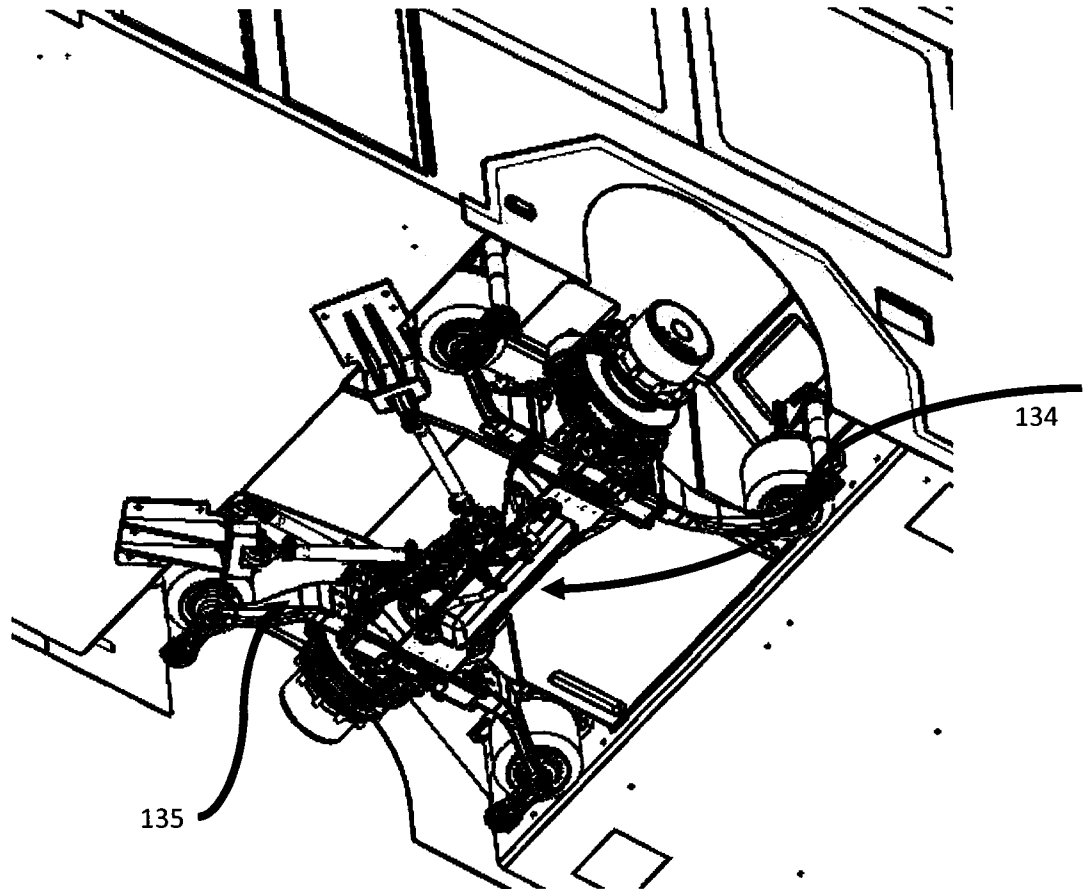


FIG. 5B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/MY2017/000004**A. CLASSIFICATION OF SUBJECT MATTER****B62D 23/00(2006.01)i, B62D 29/04(2006.01)i, B32B 5/24(2006.01)i, B32B 5/18(2006.01)i**

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B62D 23/00; B62D 33/00; B61D 17/00; B29C 53/66; B29C 53/60; B29C 70/44; B60L 7/24; B62D 29/04; B32B 5/24; B32B 5/18

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: vehicle, monocoque, bus, kevlar, glass fiber, carbon, layer

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010-0140975 A1 (CHO et al.) 10 June 2010 See paragraphs [0001]-[0006], [0024]-[0041], claim 12 and figures 1-4.	1-15
A	US 7000978 B1 (MESSANO, FRANK) 21 February 2006 See column 7, line 60 - column 10, line 16 and figures 1-18.	1-15
A	US 5988074 A (THOMAN, MELL R.) 23 November 1999 See column 3, line 60 - column 6, line 24 and figures 2-7.	1-15
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A	US 2010-0078245 A1 (ROLFE et al.) 01 April 2010 See paragraph [0220] and figure 14.	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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