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(54) **SPACER AND RELATED METHODS**

(57) This document describes, inter alia, spacers for use in constructions made of reinforced concrete as well as related methods for producing a construction made of reinforced concrete and for producing a spacer. The spacers comprise polyvinyl butyral.

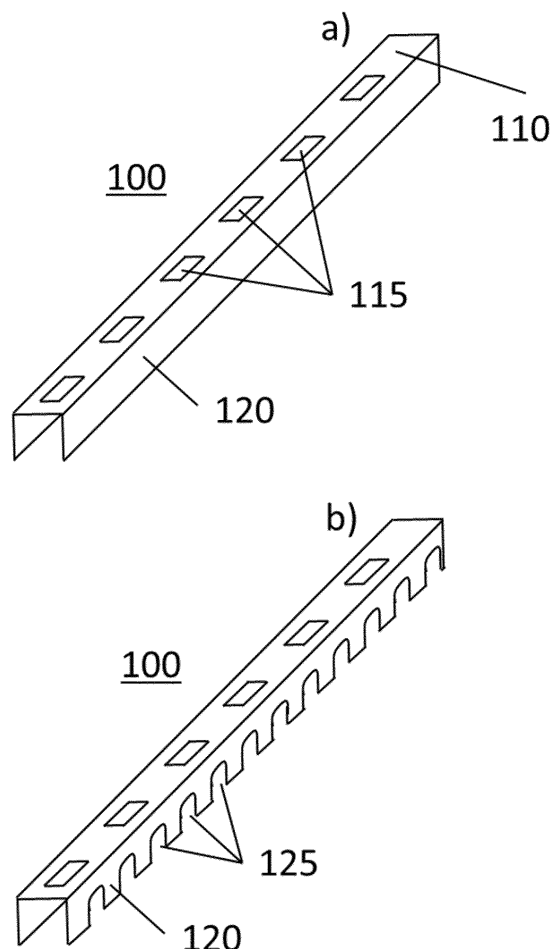


Fig. 1

Description

TECHNICAL FIELD

[0001] The present invention relates to spacers for positioning reinforcement elements in reinforced concrete, and to related methods.

TECHNOLOGICAL BACKGROUND OF THE INVENTION

[0002] Spacers are used to control the distance between reinforcement bars and the outer edge of a construction made of reinforced concrete. Traditionally, PVC spacers are used to create space between formwork or insulation on the one hand and reinforcement bars on the other hand. However, this is a brittle product: strips easily break on the building site during use or, worse still, during pouring of concrete. PVC spacers become even more brittle as a result of prolonged storage outdoors. In addition, PVC spacers become very brittle when it freezes.

[0003] Due to their brittleness and high rigidity, PVC spacers cannot be used on uneven surfaces (for example panels, insulation panels or siliceous ground) either. In addition, they cannot be used in combination with curved surfaces.

[0004] PVC spacers also have the drawback that they are heavy: at a density of approx. 1.45 kg/l of the raw material, a small pack of spacers of 100 metres easily weighs 20 kg.

[0005] The spacers according to the present invention offer a solution for one or more of the above problems.

SUMMARY

[0006] It is inter alia an object of the present invention to provide tough spacers which may be stocked both indoors and outdoors, which are lighter and which may be used in all types of weather conditions. Also provided are methods for producing such spacers and methods for producing a construction from reinforced concrete.

[0007] Thus, this document provides a method for producing a construction made of reinforced concrete, comprising the following steps:

- providing one or more spacers (100);
- providing a reinforcement cage (200), a concrete mesh or a lattice girder;
- positioning the reinforcement cage (200) by means of the one or more spacers;
- pouring concrete over the reinforcement cage (200), the concrete mesh or the lattice girder, on the one hand, and the one or more spacers (100), on the other hand;
- allowing the concrete to set;

wherein the one or more spacers (100) comprise a plastic

having elastomeric properties selected from a thermoplast, a thermoset and/or an elastomer, the spacers preferably comprising 10.0 to 80.0 wt%, more preferably 20.0 to 80.0 wt% of plastic having elastomeric properties. Preferably, the plastic having elastomeric properties comprises recycled plastic having elastomeric properties.

[0008] Preferably, the thermoplast is selected from polyvinyl chloride (PVC), polypropylene (PP), polyethylene (PE), polystyrene (PS) and/or polyvinyl butyral (PVB), wherein a thermoset is selected from bakelite, polyurethane resin, polyester, silicone and/or epoxy, and/or wherein an elastomer is selected from a thermoplastic elastomer, such as synthetic rubber, and/or a thermosetting elastomer, such as natural rubber.

[0009] Preferably, the one or more spacers (100) comprise polyvinyl butyral (PVB) and preferably the spacers comprise 5.0 to 60.0 wt% of polyvinyl butyral (PVB). Preferably, the PVB comprises recycled PVB.

[0010] In some embodiments of the method described herein, the one or more spacers furthermore comprise polypropylene (PP) and/or polyethylene (PE), preferably the spacers comprise 15.0 to 75.0 wt% of polypropylene (PP) and/or polyethylene (PE). Preferably, the PP comprises recycled PP. Preferably, the PE comprises recycled PE. In alternative embodiments of the method described herein, the one or more spacers furthermore comprise polyvinyl chloride (PVC), preferably the spacers comprise 15.0 to 75.0 wt% of polyvinyl chloride (PVC). Preferably, the PVC comprises recycled PVC. In some embodiments, the PVC comprises foamed PVC.

[0011] Preferably, the one or more spacers furthermore comprise filler, preferably 20.0 to 80.0 wt% of filler, with the filler preferably comprising chalk.

[0012] In some embodiments of the method described herein, the spacers (100) comprise 5.0 to 65.0 wt% of polyvinyl butyral (PVB); 15.0 to 75.0 wt% of polypropylene (PP) and/or polyethylene (PE); and up to 80 wt% of filler.

[0013] In some embodiments of the method described herein, the spacers (100) comprise 5.0 to 65.0 wt% of polyvinyl butyral (PVB); 15.0 to 75.0 wt% of polyvinyl chloride (PVC); and up to 80 wt% of filler.

[0014] In some embodiments, the spacer is elongate, comprises a base surface, comprises two side faces and has a U-shaped cross section.

[0015] In some embodiments, the spacer is positioned between, on the one hand, the reinforcement cage, the concrete mesh or the lattice girder and, on the other hand, a formwork.

[0016] In some embodiments, the spacer is positioned between, on the one hand, the reinforcement cage, the concrete mesh or the lattice girder and, on the other hand, an insulation material.

[0017] In addition, this document provides a spacer for reinforcement bars in a construction made of reinforced concrete which comprises a plastic having elastomeric properties selected from a thermoplast, a thermoset and/or an elastomer, wherein the spacers preferably

comprise 10.0 to 80.0 wt%, more preferably 20.0 to 80.0 wt% of plastic having elastomeric properties.

[0018] Preferably, the thermoplast is selected from polyvinyl chloride (PVC), polypropylene (PP), polyethylene (PE), polystyrene (PS) and/or polyvinyl butyral (PVB), wherein a thermoset is selected from bakelite, polyurethane resin, polyester, silicone and/or epoxy, and/or wherein an elastomer is selected from a thermoplastic elastomer, such as synthetic rubber, and/or a thermosetting elastomer, such as natural rubber.

[0019] Preferably, the spacer (100) comprises polyvinyl butyral (PVB) and preferably the spacer comprises 5.0 to 60.0 wt% of polyvinyl butyral (PVB). Preferably, the PVB comprises recycled PVB.

[0020] Preferably, the spacer (100) comprises polyvinyl butyral (PVB) and preferably the spacer comprises 10.0 to 80.0 wt% of polyvinyl butyral (PVB). Preferably, the PVB comprises recycled PVB.

[0021] In some embodiments, the spacer as described herein furthermore comprises polypropylene (PP) and/or polyethylene (PE), preferably the spacer comprises 15.0 to 75.0 wt% of polypropylene (PP) and/or polyethylene (PE). Preferably, the PP comprises recycled PP. Preferably, the PE comprises recycled PE. In alternative embodiments, the spacer as described herein furthermore comprises polyvinyl chloride (PVC), preferably the spacer comprises 15.0 to 75.0 wt% of polyvinyl chloride (PVC). Preferably, the PVC comprises recycled PVC. In some embodiments, the PVC comprises foamed PVC. Preferably, the spacer furthermore comprises filler, preferably 20.0 to 90.0 wt%, more preferably 20.0 to 80.0 wt% of filler, with the filler preferably comprising chalk. In some embodiments, the spacer comprises 20.0 to 40.0 wt% of chalk.

[0022] In some embodiments, the spacer as described herein comprises 5.0 to 65.0 wt% of polyvinyl butyral (PVB); 15.0 to 75.0 wt% of polypropylene (PP) and/or polyethylene (PE); and up to 80 wt% of filler.

[0023] In some embodiments, the spacer comprises 20.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of PP, and up to 30.0 wt% of filler.

[0024] In some embodiments, the spacer comprises 20.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of polyethene (PE), and up to 30 wt% of filler.

[0025] In some embodiments, the spacer as described herein comprises 5.0 to 65.0 wt% of polyvinyl butyral (PVB); 15.0 to 75.0 wt% of polyvinyl chloride (PVC); and up to 80 wt% of filler.

[0026] In some embodiments, the spacer comprises 20.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of polyvinyl chloride (PVC), and up to 30 wt% of filler.

[0027] In some embodiments, the spacer comprises 10.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of polyvinyl chloride (PVC), and up to 70 wt% of filler.

[0028] In some embodiments, the spacer is elongate, comprises a base surface, comprises two side faces and has a U-shaped cross section.

[0029] In some embodiments, the spacer is positioned

between, on the one hand, the reinforcement cage, the concrete mesh or the lattice girder and, on the other hand, a formwork.

[0030] In some embodiments, the spacer is positioned between, on the one hand, the reinforcement cage, the concrete mesh or the lattice girder and, on the other hand, an insulation material.

[0031] Furthermore, this document provides a method for producing a spacer (100) as described herein, the method comprising the following steps:

- extruding a melt to form a spacer preform, wherein the melt comprises a plastic having elastomeric properties selected from a thermoplast, a thermoset and/or an elastomer, preferably wherein a thermoplast is selected from polyvinyl chloride (PVC), polypropylene (PP), polyethylene (PE), polystyrene (PS) and/or polyvinyl butyral (PVB), wherein a thermoset is selected from bakelite, polyurethane resin, polyester, silicone and/or epoxy, and/or wherein an elastomer is selected from a thermoplastic elastomer, such as synthetic rubber, and/or a thermosetting elastomer, such as natural rubber, and preferably comprises polyvinyl butyral, with the melt preferably comprising 5.0 to 60.0 wt% of polyvinyl butyral (PVB);
- cooling the spacer preform;
- sawing off or cutting off the spacer preform, thereby forming a spacer (100).

[0032] In alternative embodiments, the method for producing a spacer (100) as described herein comprises the following steps:

- injection-moulding a melt to form a spacer, wherein the melt comprises a plastic having elastomeric properties selected from a thermoplast, a thermoset and/or an elastomer, preferably wherein a thermoplast is selected from polyvinyl chloride (PVC), polypropylene (PP), polyethylene (PE), polystyrene (PS) and/or polyvinyl butyral (PVB), wherein a thermoset is selected from bakelite, polyurethane resin, polyester, silicone and/or epoxy, and/or wherein an elastomer is selected from a thermoplastic elastomer, such as synthetic rubber, and/or a thermosetting elastomer, such as natural rubber and preferably comprises polyvinyl butyral, with the melt preferably comprising 5.0 to 80.0 wt%, more preferably 10.0 to 80.0 wt%, still more preferably 5.0 to 60.0 wt% of polyvinyl butyral (PVB). The following description of the melt applies both to the injection-moulding method and to the extrusion method.

[0033] In some embodiments, the melt furthermore comprises polypropylene (PP) and/or polyethylene (PE), wherein the melt preferably comprises 15.0 to 75.0 wt% of polypropylene (PP) and/or polyethylene (PE).

[0034] In some embodiments, the melt furthermore

comprises polyvinyl chloride (PVC), wherein the melt preferably comprises 15.0 to 75.0 wt% of polyvinyl chloride (PVC).

[0035] In some embodiments, the melt furthermore comprises a blowing agent.

[0036] In some embodiments, the blowing agent comprises CO₂ and/or N₂, or with the blowing agent forming CO₂ and/or N₂ during extrusion.

[0037] In some embodiments, the melt furthermore comprises a filler, preferably 20.0 to 90.0 wt%, more preferably 20.0 to 80.0 wt% of filler, with the filler preferably comprising chalk. In some embodiments, the melt comprises 20.0 to 40.0 wt% of chalk.

[0038] In some embodiments, the melt comprises 5.0 to 65.0 wt% of polyvinyl butyral (PVB); 15.0 to 75.0 wt% of polypropylene (PP) and/or polyethylene (PE); and up to 80 wt% of filler.

[0039] In some embodiments, the melt comprises 20.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of PP, and up to 30.0 wt% of filler.

[0040] In some embodiments, the melt comprises 20.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of PE, and up to 30.0 wt% of filler.

[0041] In some embodiments, the melt comprises 5.0 to 65.0 wt% of polyvinyl butyral (PVB); 15.0 to 75.0 wt% of polyvinyl chloride (PVC); and up to 80 wt% of filler.

[0042] In some embodiments, the melt comprises 20.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of PVC, and up to 30.0 wt% of filler.

[0043] In some embodiments, the plastic having elastomeric properties comprises recycled plastic having elastomeric properties, preferably the PP comprises recycled PP, preferably the PE comprises recycled PE, preferably the PVC comprises recycled PVC, preferably the PVB comprises recycled PVB.

[0044] In some embodiments, the PVC comprises foamed PVC.

DESCRIPTION OF THE FIGURES

[0045] The following description of the figures relates to specific embodiments of the present invention and is only given by way of example. This description is non-limiting with regard to the teaching which is described herein, the applications thereof, or the use thereof. In the figures, identical reference numerals are used to refer to identical or similar devices or components.

Fig. 1 shows two embodiments of a spacer as provided herein.

Fig. 2 shows a curved spacer around a reinforcement cage of reinforcing steel.

Fig. 3 shows an extrusion line for continuous extrusion of a spacer as provided herein.

Fig. 4 shows how elongate spacers (100) may be stacked.

Fig. 5 shows alternative forms of spacers (100).

Fig. 6 shows a comparison of tensile-strength tests,

pressure tests and bending tests of spacers (100) consisting of different materials. A, B and C are commercially available materials, D consists of recycled foamed PVC in combination with 10% PVB, E consists of recycled PVC micronisate, F consists of recycled PVC micronisate in combination with 10% PVB, and G consists of recycled PVC micronisate in combination with 20% PVB.

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[0046] The following reference numerals are used in the description and in the figures:

1 - hopper; 2 - screw; 3 - die; 4 - calibration tool; 5 - cooler; 6 - pulling mechanism; 7 device for sawing and punching; 8 - packaging station; 100 - spacer; 110 - base; 115 - opening in base; 120 - side face; 125 - opening in side face; 200 - reinforcement cage; α - angle between side face and base.

DETAILED DESCRIPTION

[0047] As used below in this text, the singular forms "a", "an", "the" include both the singular and the plural, unless the context clearly indicates otherwise.

[0048] The terms "comprise", "comprises" as used below are synonymous with "including", "include" or "contain", "contains" and are inclusive or open and do not exclude additional unmentioned parts, elements or method steps. Where this description refers to a product or process which "comprises" specific features, parts or steps, this refers to the possibility that other features, parts or steps may also be present, but this may also refer to embodiments which only contain the listed features, parts or steps.

[0049] The enumeration of numeric values by means of ranges of figures comprises all values and fractions in these ranges, as well as the cited end points.

[0050] The term "approximately" as used when referring to a measurable value, such as a parameter, an amount, a time period, and the like, is intended to include variations of +/- 10% or less, preferably +/-5% or less, more preferably +/-1% or less, and still more preferably +/-0.1% or less, of and from the specified value, in so far as the variations apply to the disclosed invention. It should be understood that the value to which the term "approximately" refers per se has also been disclosed.

[0051] All references cited in this description are hereby deemed to be incorporated in their entirety by way of reference.

[0052] Unless defined otherwise, all terms disclosed in the invention, including technical and scientific terms, have the meaning which a person skilled in the art usually gives them. For further guidance, definitions are included to further explain terms which are used in the description of the invention.

[0053] The abbreviation wt% as used herein refers to weight percent. For example, the expression "mixture m comprises x wt% of component a and y wt% of component b" means that mixture m comprises x weight units

of component a and y weight units of component b per 100 weight units of mixture m.

[0054] It is an object of the present invention, inter alia, to provide tough spacers which can be stocked both indoors and outdoors, which are lighter and which can be used in all kinds of weather conditions. In addition, methods are provided for producing such spacers and methods for producing a construction from reinforced concrete.

[0055] Thus, this document provides a method for producing a construction made of reinforced concrete comprising the following steps:

- providing one or more spacers (100);
- providing a reinforcement cage (200), a concrete mesh or a lattice girder;
- positioning the reinforcement cage (200) by means of the one or more spacers;
- pouring concrete over the reinforcement cage (200), the concrete mesh or the lattice girder, on the one hand, and the one or more spacers (100), on the other hand;
- allowing the concrete to set;

wherein the one or more spacers (100) comprise a plastic having elastomeric properties selected from a thermoplastic, a thermoset and/or an elastomer, the spacers preferably comprising 10.0 to 80.0 wt%, more preferably 20.0 to 80.0 wt% of plastic having elastomeric properties. Preferably, the plastic having elastomeric properties comprises recycled plastic having elastomeric properties.

[0056] Preferably, the thermoplastic is chosen from polyvinyl chloride (PVC), polypropylene (PP), polyethylene (PE), polystyrene (PS) and/or polyvinyl butyral (PVB), wherein a thermoset is selected from bakelite, polyurethane resin, polyester, silicone and/or epoxy, and/or wherein an elastomer is selected from a thermoplastic elastomer, such as synthetic rubber, and/or a thermosetting elastomer, such as natural rubber.

[0057] In some embodiments, the spacer comprises 10.0 to 80.0 wt%, preferably 20.0 to 80.0 wt% of a plastic having elastomeric properties selected from a thermoplastic, a thermoset and/or an elastomer; 10.0 to 80.0 wt%, preferably 20.0 to 80.0 wt% of PP, polyethylene (PE) and/or polyvinyl chloride (PVC); and preferably up to 30 wt% of filler.

[0058] As described herein, the term thermoplastic refers to meltable polymers which can be poured into a die. These polymers usually consist of unbranched or lightly branched chains consisting of one or more kinds of monomers. Thermoplasts are often turned into the desired shape by melting them and injecting them into a die.

[0059] As described herein, the term thermoset refers to a polymer in which chains are linked to each other by the addition of a crosslinker. As a result thereof, the polymers assume the shape of a network polymer. Thermosets will, for example, have to be introduced into a mould as two components, where they react to form the final

polymer. Due to the mutual connection of the chains, the polymer almost forms one large molecule.

[0060] As described herein, the term elastomer refers to a polymer which contains a limited number of crosslinks, as a result of which the molecules are elastic.

[0061] The expression "plastic having elastomeric properties" as used herein, preferably refers to a plastic which can undergo elastic deformation. As used herein, the plastic having elastomeric properties may be a mixture of different plastics.

[0062] Preferably, the plastic having elastomeric properties is a plastic having a modulus of elasticity (E) of at least 1.00 GPa, preferably at least 1.25 GPa, preferably at least 1.50 GPa, preferably at least 1.75 GPa, preferably at least 2.00 GPa, preferably at least 2.10 GPa, preferably at least 2.20 GPa, preferably at least 2.50 GPa. Preferably, the plastic having elastomeric properties is a plastic having a modulus of elasticity (E) of at most 5.00 GPa, preferably at most 4.00 GPa, preferably at most 3.50 GPa, preferably at most 3.00 GPa, preferably at most 2.70 GPa, preferably at most 2.50 GPa, preferably at most 2.40 GPa, preferably at most 2.30 GPa, preferably at most 2.25 GPa. Preferably, the modulus of elasticity is determined during a tensile-strength test. Preferably, the modulus of elasticity is determined during a pressure test. Preferably, the modulus of elasticity is determined during a bending test. Preferably, the modulus of elasticity is determined in accordance with ISO 527:2019.

[0063] Preferably, the plastic having elastomeric properties is a plastic having a tensile strength of at least 10.00 MPa, preferably at least 15.00 MPa, preferably at least 17.00 MPa, preferably at least 20.00 MPa, preferably at least 22.00 MPa, preferably at least 25.00 MPa, preferably at least 27.00 MPa, preferably at least 30.00 MPa, preferably at least 32.00 MPa. Preferably, the plastic having elastomeric properties is a plastic having a tensile strength of at most 75.00 MPa, preferably at most 50.00 MPa, preferably at most 45.00 MPa, preferably at most 40.00 MPa, preferably at most 37.00 MPa, preferably at most 35.00 MPa, preferably at most 33.00 MPa. Preferably, the modulus of elasticity is determined during a tensile-strength test. Preferably, the modulus of elasticity is determined during a pressure test. Preferably, the modulus of elasticity is determined during a bending test. Preferably, the modulus of elasticity is determined in accordance with ISO 527:2019.

[0064] Preferably, the plastic having elastomeric properties is a plastic having a flowing point of at least 10.00 MPa, preferably at least 15.00 MPa, preferably at least 17.00 MPa, preferably at least 20.00 MPa, preferably at least 22.00 MPa, preferably at least 25.00 MPa, preferably at least 27.00 MPa, preferably at least 30.00 MPa, preferably at least 32.00 MPa. Preferably, the plastic having elastomeric properties is a plastic having a flowing point of at most 75.00 MPa, preferably at most 50.00 MPa, preferably at most 45.00 MPa, preferably at most 40.00 MPa, preferably at most 37.00 MPa, preferably at

most 35.00 MPa, preferably at most 33.00 MPa. Preferably, the flowing point is determined during a pressure test. Preferably, the plastic having elastomeric properties is a plastic in which bending of 1.5 times the thickness of the sample can be achieved using a force of at least 30.00 MPa, preferably at least 35.00 MPa, preferably at least 40.00 MPa, preferably at least 45.00 MPa, preferably at least 50.00 MPa, preferably at least 55.00 MPa, preferably at least 57.00 MPa, preferably at least 60.00 MPa. This document provides a spacer for reinforcement bars in a construction made of reinforced concrete. In some embodiments, the spacer comprises polyvinyl butyral (PVB). The spacer may be pointed, linear or flat, and may or may not be connected to the reinforcement bars. Spacers as such are described in, for example, "Merkblätter Deutscher Beton- und Bautechnik-Verein e.v., Abstandhalter nach Eurocode 2. Fassung Januar 2011", which are hereby incorporated in their entirety in the present application by way of reference.

[0065] Preferably, the one or more spacers (100) comprise polyvinyl butyral (PVB) and preferably the spacers comprise 5.0 to 60.0 wt% of polyvinyl butyral (PVB). Preferably, the PVB comprises recycled PVB.

[0066] In some embodiments, the spacer comprises 5.0 wt% to 90.0 wt% of PVB. In some embodiments, the spacer comprises 10.0 wt% to 80.0 wt% of PVB. In some embodiments, the spacer comprises 15.0 wt% to 70.0 wt% of PVB. In some embodiments, the spacer comprises 20.0 wt% to 60.0 wt% of PVB. In some embodiments, the spacer comprises 25.0 wt% to 50.0 wt% of PVB. In some embodiments, the spacer comprises 30.0 wt% to 40.0 wt% of PVB. In some embodiments, the spacer comprises 32.5 wt% to 35.0 wt% of PVB. In some embodiments, the spacer comprises 70.0 wt% to 90.0 wt% of PVB. In some embodiments, the spacer comprises 75.0 wt% to 85.0 wt% of PVB.

[0067] Preferably, the spacer comprises 5.0 wt% to 30.0 wt% of PVB, preferably 5.0 wt% to 25.0 wt% of PVB, preferably 5.0 wt% to 20.0 wt% of PVB and still more preferably 5.0 wt% to 15.0 wt% of PVB.

[0068] In some embodiments, the spacer is porous. This may be achieved, for example, by using a blowing agent during production of the spacer. Suitable porous plastics are microcellular plastics which comprise PVB, and preferably microcellular plastics which comprise PVB and PP, PE and/or PVC in the concentrations which are described here. Such spacers are lighter while having the same mechanical strength.

[0069] Preferably, recycled PVB is used, for example recycled PVB which originates from car windows or from production waste originating from the production of car windows. Thus, for example, recycled PVB originating from scrap car windows is suitable, as is PVB cutting waste. Another suitable source of PVB is off-spec PVD.

[0070] This document provides a spacer for reinforcement bars in a construction made of reinforced concrete which comprises polyvinyl butyral (PVB). In some embodiments, the one or more spacers furthermore com-

prise polypropylene (PP) and/or polyethylene (PE), preferably the spacers comprise 15.0 to 75.0 wt% of polypropylene (PP) and/or polyethylene (PE). Preferably, the PP comprises recycled PP. Preferably, the PE comprises recycled PE.

[0071] In some embodiments, the spacer furthermore comprises polypropylene (PP) or polyethylene (PE). Polypropylene and polyethylene are relatively light, having a typical density of less than 0.95 kg/l.

[0072] When the spacer comprises PVB and PP and/or PE, preferably when the spacer consists for at least 15, 20, 30, 40, 50, 60, 70, 80, 90, 99, 99.9 or for 100% of PVB and PP and/or PE and optionally filler, the spacer has particularly favourable properties, particularly when compared to spacers which are only based on polyvinyl chloride (PVC). Thus, the spacer preferably consists of PVB and PP and/or PE and optionally filler. In other words, the spacer preferably consists for 100% of a mixture of PVB and PP and/or PE and optionally filler. Such spacers are semi-flexible and yet sufficiently strong: polypropylene and polyethylene are hard, strong and rigid. The latter are also tougher than PVC and thus more difficult to break. In addition, polypropylene and polyethylene are corrosion-proof and they are resistant to chemical action.

[0073] The spacers based on PVB and PP and/or PE are also lighter per linear metre than PVC spacers.

[0074] In addition, spacers made of PVB and PP and/or PE and optionally filler are easier to separate from concrete after demolition as a result of water-based flotation techniques. This is due to the low density of PVB and PP and/or PE. The density of PVB in combination with PP and/or PE is approx. 0.95 kg/l. The density of the spacers can be reduced further by incorporating pores, which can be achieved by using a blowing agent during production of the spacer. In this way, the spacer becomes even lighter. Lighter spacers are easier to use and transport and can be separated even more easily from the reinforced concrete in which they are incorporated after demolition by means of water-based flotation. Another advantage of spacers which consist of PVB and PP and/or PE and optionally filler is that they can be produced by means of extrusion and that their dies then have a very long service life of approx. 10 years. By contrast, due to the chlorine content of PVC, PVC extrusion dies have a shorter service life of 2 to 5 years.

[0075] In addition, when heating PP and/or PE, no dangerous substances are released and no problems related to heat-induced aging occur either. An extrusion process of PP and/or PE spacers can thus also be started up easily since any possible hotspots are less critical.

[0076] In some embodiments of the method described herein, the spacers (100) comprise 5.0 to 65.0 wt% of polyvinyl butyral (PVB); 15.0 to 75.0 wt% of polypropylene (PP) and/or polyethylene (PE); and up to 80 wt% of filler.

[0077] This document provides a spacer for reinforcement bars in a construction made of reinforced concrete

which comprises polyvinyl butyral (PVB). In some embodiments, the spacer furthermore comprises polyvinyl chloride (PVC), preferably the spacers comprise 15.0 to 75.0 wt% of polyvinyl chloride (PVC). Preferably, the PVC comprises recycled PVC. In some embodiments, the PVC comprises foamed PVC. In some embodiments of the method described herein, the spacers (100) comprise 5.0 to 65.0 wt% of polyvinyl butyral (PVB); 15.0 to 75.0 wt% of polyvinyl chloride (PVC); and up to 80 wt% of filler. Compared to spacers which are made entirely from PVC (and optionally filler), the spacers based on a PVC-PVB mixture also have the advantage that they are tougher. In addition, it has also been found that when the amount of PVB is between 5.0 and 15.0 wt%, the material also has better technical properties, such as increased tensile strength, bending strength and compressive strength.

[0078] In some embodiments, the spacer comprises a filler. A suitable filler is chalk. As an alternative to chalk, it is for example possible to use calcium carbonate, kaolin, magnesium hydroxide, glass, wollastonite, or titanium dioxide.

[0079] Preferably, the one or more spacers furthermore comprise filler, 20.0 to 90.0 wt% of filler, preferably 20.0 to 80.0 wt% of filler, preferably 20.0 to 60.0 wt% of filler, with the filler preferably comprising chalk.

[0080] In some embodiments, the spacer comprises 1.0 to 40.0 wt% of chalk, or 5.0 to 37.0 wt% of chalk, or 10.0 to 40.0 wt% of chalk, or 15.0 to 35.0 wt% of chalk, or 20.0 to 30.0 wt% of chalk, or 30.0 to 33.0 wt% of chalk.

[0081] In some embodiments, the spacer is elongate and the spacer has a U-shaped cross section. Thus, in these embodiments, the spacer comprises a base surface, two side faces, and a U-shaped cross section. In other words, such a spacer has the shape of an open gutter. The edges and/or the base of this spacer is optionally perforated. In some embodiments, these spacers have a length of 0.5 to 5.0 m, for example a length of 1.0 to 4.0 m, for example a length of 1.5 to 3.0 m, for example a length of 1.5 to 2.5 m, for example a length of 2.0 to 2.5 m.

[0082] These spacers are very easy to use and are suitable as spacers between reinforcement bars on the one hand and a formwork, insulation material or a soft surface on the other hand.

[0083] In some embodiments, the base surface and/or the side faces of the elongate spacer comprise several openings. Firstly, this has the advantage that the spacer can easily be filled with concrete, including gravel. In addition, a weight saving is achieved. Preferably, the openings are evenly distributed. In some embodiments, the openings of such spacers open into the edge of the spacer, i.e. they are connected to the edge of the side faces of the spacer. In this case, they ensure that the edge of the side faces has an undulating or serrated profile, as is shown, for example, in Fig. 1, panel b. In some embodiments, the openings in the side faces of the spacer are not connected to the edge, so that the edge runs on

in a straight line. Providing openings in the side faces lowers the weight of the spacer per unit length. This spacer is extremely suitable for use between a reinforcement cage, concrete mesh or lattice girder on the one hand and a formwork on the other hand.

[0084] Preferably, the base surface of the elongate spacer comprises several openings. Preferably, the spacers with openings in the side faces are used to keep reinforcement bars at a distance from a formwork (see Fig. 1b). The advantage of this form factor is a reduction in weight.

[0085] In some embodiments, the side faces of the spacer do not comprise openings and the edge of the side faces runs continuously in a substantially straight line. Preferably, spacers without openings in the side faces or at least with side faces having a straight, continuous edge are used to keep reinforcement bars at a distance from a soft surface and/or from insulation. This reduces the pressure on the soft surface / insulation, which reduces the risk of damage (see Fig. 1a).

[0086] Optionally, the side faces are at a right angle with the base, that is at an angle of 90.0° with respect to the base.

[0087] Optionally, the side faces are at an obtuse angle with respect to the base, for example at an angle of 100.0° to 140.0°, or 110.0° to 130.0°, or 120.0° to 125.0°.

[0088] Optionally, the spacer may have a different, non-elongate shape. Thus, the spacer is ring-shaped in some embodiments (see Fig. 5, panel a). In some embodiments, the spacer is star-shaped (see Fig. 5, panel b).

[0089] PVB can be mixed with PP without the loss of the advantageous properties of PP. In some embodiments, the spacer comprises PP and PVB, wherein the spacer comprises 10.0 to 80.0 wt%, or 20.0 to 80.0 wt%, or 20.0 to 70.0 wt%, or 20.0 to 60.0 wt%, or 20.0 to 50.0 wt%, or 25.0 to 45.0 wt%, or 30.0 to 40.0 wt%, or 32.5 to 37.5 wt%, or 35.0 wt% of PVB. Preferably, the spacer comprises 20.0 to 80.0 wt%, or 30.0 to 80.0 wt%, or 40.0 to 80.0 wt%, or 50.0 to 80.0 wt%, or 55.0 to 75.0 wt%, or 60.0 to 70.0 wt%, or 62.5 to 67.5 wt%, or 65.0 wt% of PP. Optionally, the spacer comprises up to 20 wt% or up to 30 wt% of filler.

[0090] Preferably, the spacer comprises 20.0 to 50.0 wt% of PVB, 50.0 to 80.0 wt% of PP, and up to 30 wt% of filler. In some embodiments, the spacer comprises 20.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of PP, and up to 20 wt% of filler. In some embodiments, the spacer comprises 20.0 to 70.0 wt% of PVB, 30.0 to 80.0 wt% of PP, and up to 20 wt% of filler. In some embodiments, the spacer comprises 20.0 to 60.0 wt% of PVB, 40.0 to 80.0 wt% of PP, and up to 20 wt% of filler. In some embodiments, the spacer comprises 25.0 to 45.0 wt% of PVB, or 55.0 to 75.0 wt% of PP, and up to 20 wt% of filler. In some embodiments, the spacer comprises 30.0 to 40.0 wt% of PVB, 60.0 to 70.0 wt% of PP, and up to 10% of filler. In some embodiments, the spacer comprises from 32.5 to 37.5 wt% of PVB, 62.5 to 67.5 wt% of PP, and

up to 5.0 wt% of filler. In some embodiments, the spacer comprises 35.0 wt% of PVB and 65.0 wt% of PP.

[0091] Preferably, the spacer comprises recycled PP.

[0092] Preferably, the spacer comprises recycled PVB.

[0093] In some embodiments, the spacer comprises polyethylene (PE) and PVB, wherein the spacer comprises 10.0 to 80.0 wt%, or 20.0 to 80.0 wt%, or 20.0 to 70.0 wt%, or 20.0 to 60.0 wt%, or 20.0 to 50.0 wt%, or 25.0 to 45.0 wt%, or 30.0 to 40.0 wt%, or 32.5 to 37.5 wt%, or 35.0 wt% of PVB.

[0094] In some embodiments, the spacer comprises 10.0 to 80.0 wt%, or 20.0 to 80.0 wt%, or 30.0 to 80.0 wt%, or 40.0 to 80.0 wt%, or 50.0 to 80.0 wt%, or 55.0 to 75.0 wt%, or 60.0 to 70.0 wt%, or 62.5 to 67.5 wt%, or 65.0 wt% of PE. Optionally, the spacer comprises up to 20 wt% or up to 30 wt% of filler. In some embodiments, the spacer comprises 10.0 to 80.0 wt%, or 20.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of PE, and up to 20 wt% of filler. In some embodiments, the spacer comprises 20.0 to 70.0 wt% of PVB, 30.0 to 80.0 wt% of PE, and up to 20 wt% of filler. In some embodiments, the spacer comprises 20.0 to 60.0 wt% of PVB, 40.0 to 80.0 wt% of PE, and up to 20 wt% of filler. In some embodiments, the spacer comprises 20.0 to 50.0 wt% of PVB, 50.0 to 80.0 wt% of PE, and up to 30 wt% of filler. In some embodiments, the spacer comprises 25.0 to 45.0 wt% of PVB, or 55.0 to 75.0 wt% of PE, and up to 20 wt% of filler. In some embodiments, the spacer comprises 30.0 to 40.0 wt% of PVB, 60.0 to 70.0 wt% of PE, and up to 10% filler. In some embodiments, the spacer comprises 32.5 to 37.5 wt% of PVB, 62.5 to 67.5 wt% of PE, and up to 5.0 wt% of filler. In some embodiments, the spacer comprises 35.0 wt% of PVB and 65.0 wt% of PE.

[0095] In some embodiments, the PE comprises recycled PE.

[0096] Just like PP, PE also has the advantage that it is light which facilitates water-flotation separation of concrete and spacers after decommissioning of a concrete construction in which the spacer has been incorporated. However, by contrast, PE is also tough and strong. Also, when PE catches fire, no toxic fumes develop.

[0097] In some embodiments, the spacer comprises PVB, PE, PP, and optionally filler. In other words, PP and PE may both be incorporated in the spacer in addition to PVB.

[0098] In some embodiments, the spacer comprises polyvinyl chloride (PVC) and PVB, wherein the spacer comprises 10.0 to 80.0 wt%, or 20.0 to 80.0 wt%, or 20.0 to 70.0 wt%, or 20.0 to 60.0 wt%, or 20.0 to 50.0 wt%, or 25.0 to 45.0 wt%, or 30.0 to 40.0 wt%, or 32.5 to 37.5 wt%, or 35.0 wt% of PVB. In some embodiments, the spacer comprises 10.0 to 80.0 wt%, or 20.0 to 80.0 wt%, or 30.0 to 80.0 wt%, or 40.0 to 80.0 wt%, or 50.0 to 80.0 wt%, or 55.0 to 75.0 wt%, or 60.0 to 70.0 wt%, or 62.5 to 67.5 wt%, or 65.0 wt% of PVC. Optionally, the spacer comprises up to 20 wt% or up to 30 wt% of filler.

[0099] In some embodiments, the spacer comprises

20.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of PVC, and up to 20 wt% of filler. In some embodiments, the spacer comprises 20.0 to 70.0 wt% of PVB, 30.0 to 80.0 wt% of PVC, and up to 20 wt% of filler. In some embodiments, the spacer comprises 20.0 to 60.0 wt% of PVB, 40.0 to 80.0 wt% of PVC, and up to 20 wt% of filler. In some embodiments, the spacer comprises 20.0 to 50.0 wt% of PVB, 50.0 to 80.0 wt% of PVC, and up to 30 wt% of filler. In some embodiments, the spacer comprises 25.0 to 45.0 wt% of PVB, or 55.0 to 75.0 wt% of PVC, and up to 20 wt% of filler. In some embodiments, the spacer comprises 30.0 to 40.0 wt% of PVB, 60.0 to 70.0 wt% of PVC, and up to 10% filler. In some embodiments, the spacer comprises 32.5 to 37.5 wt% of PVB, 62.5 to 67.5 wt% of PVC, and up to 5.0 wt% of filler. In some embodiments, the spacer comprises 35.0 wt% of PVB and 65.0 wt% of PVC.

[0100] In some embodiments, the PVC comprises recycled PVC. In some embodiments, the PVC comprises foamed PVC.

[0101] In addition, this document provides a method for producing a construction made of reinforced concrete. The method comprises providing one or more spacers and arranging a reinforcement cage, concrete mesh or lattice girder. The exact position of the reinforcement cage, concrete mesh or lattice girder is in particular controlled by means of the one or more spacers. Subsequently, concrete is poured over the reinforcement cage, concrete mesh or lattice girder and the one or more spacers and the concrete sets. In this way, a construction made of reinforced concrete is produced. The one or more spacers are spacers as described herein and comprise polyvinyl butyral. Spacers which comprise both polyvinyl butyral and polypropylene are particularly suitable, inter alia because of their toughness and strength. After the concrete has set, the one or more spacers form part of the construction made of reinforced concrete. In other words, the one or more spacers remain in place; they do not have to be removed after setting has taken place.

[0102] In some embodiments, the spacer is positioned between, on the one hand, the reinforcement cage, concrete mesh or lattice girder and, on the other hand, a formwork.

[0103] In some embodiments, the spacer is positioned between, on the one hand, a soft surface, for example insulation material, and, on the other hand, the reinforcement cage, concrete mesh or lattice girder. Preferably, an elongate spacer having a U-shaped cross section is used. Such spacers can also easily be used in corners by cutting the lateral flanges (the side faces) open and bending the spacer at the location of the cut. In this way, in some embodiments, the method comprises the step of cutting the side faces of a spacer and bending the spacer around a corner of the reinforcement cage, concrete mesh or lattice girder.

[0104] Furthermore, this document provides a spacer for reinforcement bars in a construction made of reinforced concrete which comprises a plastic having elas-

tomeric properties selected from a thermoplast, a thermoset and/or an elastomer, wherein the spacers comprise preferably 20.0 to 80.0 wt% of plastic having elastomeric properties.

[0105] Preferably, the thermoplast is selected from polyvinyl chloride (PVC), polypropylene (PP), polyethylene (PE), polystyrene (PS) and/or polyvinyl butyral (PVB), wherein a thermoset is selected from bakelite, polyurethane resin, polyester, silicone and/or epoxy, and/or wherein an elastomer is selected from a thermoplastic elastomer, such as synthetic rubber, and/or a thermosetting elastomer, such as natural rubber.

[0106] Preferably, the spacer (100) comprises polyvinyl butyral (PVB) and preferably the spacer comprises 5.0 to 60.0 wt% of polyvinyl butyral (PVB). Preferably, the PVB comprises recycled PVB.

[0107] In some embodiments, the spacer as described herein furthermore comprises polypropylene (PP) and/or polyethylene (PE), preferably the spacer comprises 15.0 to 75.0 wt% of polypropylene (PP) and/or polyethylene (PE). Preferably, the PP comprises recycled PP. Preferably, the PE comprises recycled PE. In alternative embodiments, the spacer as described herein furthermore comprises polyvinyl chloride (PVC), preferably the spacer comprises 15.0 to 75.0 wt% of polyvinyl chloride (PVC). Preferably, the PVC comprises recycled PVC. In some embodiments, the PVC comprises foamed PVC and preferably recycled foamed PVC.

[0108] The use of recycled materials is important from an environmental point of view in the context of a circular economy. The re-use of foamed PVC in particular has proved to be useful, since this cannot be re-used in the existing recycling streams.

[0109] Preferably, the spacer furthermore comprises filler, preferably 10.0 to 80.0 wt% of filler, preferably 20.0 to 80.0 wt% of filler, with the filler preferably comprising chalk. In some embodiments, the spacer comprises 20.0 to 40.0 wt% of chalk.

[0110] In some embodiments, the spacer as described herein comprises 5.0 to 65.0 wt% of polyvinyl butyral (PVB); 15.0 to 75.0 wt% of polypropylene (PP) and/or polyethylene (PE); and up to 80 wt% of filler.

[0111] In some embodiments, the spacer comprises 20.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of PP, and up to 30.0 wt% of filler.

[0112] In some embodiments, the spacer comprises 10.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of PP, and up to 30.0 wt% of filler.

[0113] In some embodiments, the spacer comprises 20.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of polyethylene (PE), and up to 30 wt% of filler.

[0114] In some embodiments, the spacer comprises 10.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of polyethylene (PE), and up to 30 wt% of filler.

[0115] In some embodiments, the spacer as described herein comprises 5.0 to 65.0 wt% of polyvinyl butyral (PVB); 15.0 to 75.0 wt% of polyvinyl chloride (PVC); and up to 80 wt% of filler.

[0116] In some embodiments, the spacer comprises 20.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of polyvinyl chloride (PVC), and up to 30 wt% of filler.

[0117] In some embodiments, the spacer comprises 10.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of polyvinyl chloride (PVC), and up to 30 wt% of filler.

[0118] In some embodiments, the spacer is elongate, comprises a base surface, comprises two side faces and has a U-shaped cross section.

[0119] In some embodiments, the spacer is positioned between, on the one hand, the reinforcement cage, the concrete mesh or the lattice girder and, on the other hand, a formwork.

[0120] In some embodiments, the spacer is positioned between, on the one hand, the reinforcement cage, the concrete mesh or the lattice girder and, on the other hand, an insulation material.

[0121] Furthermore, this document provides a method for producing a spacer (100) as described herein, the method comprising the following steps:

- extruding a melt to form a spacer preform, wherein the melt comprises a plastic having elastomeric properties selected from a thermoplast, a thermoset and/or an elastomer, preferably wherein a thermoplast is selected from polyvinyl chloride (PVC), polypropylene (PP), polyethylene (PE), polystyrene (PS) and/or polyvinyl butyral (PVB), wherein a thermoset is selected from bakelite, polyurethane resin, polyester, silicone and/or epoxy, and/or wherein an elastomer is selected from a thermoplastic elastomer, such as synthetic rubber, and/or a thermosetting elastomer, such as natural rubber, and preferably comprises polyvinyl butyral, with the melt preferably comprising 5.0 to 60.0 wt% of polyvinyl butyral (PVB);
- cooling the spacer preform, preferably by means of water;
- sawing off or cutting off the spacer preform, thereby forming a spacer (100).

[0122] In alternative embodiments, the method for producing a spacer (100) as described herein comprises the following steps:

- injection-moulding a melt to form a spacer, wherein the melt comprises a plastic having elastomeric properties selected from a thermoplast, a thermoset and/or an elastomer, preferably wherein a thermoplast is selected from polyvinyl chloride (PVC), polypropylene (PP), polyethylene (PE), polystyrene (PS) and/or polyvinyl butyral (PVB), wherein a thermoset is selected from bakelite, polyurethane resin, polyester, silicone and/or epoxy, and/or wherein an elastomer is selected from a thermoplastic elastomer, such as synthetic rubber, and/or a thermosetting elastomer, such as natural rubber and preferably comprises polyvinyl butyral, with the melt preferably

comprising 5.0 to 60.0 wt% of polyvinyl butyral (PVB).

[0123] The following description of the melt applies both to the injection-moulding method and to the extrusion method.

[0124] In some embodiments, the melt furthermore comprises polypropylene (PP) and/or polyethylene (PE), wherein the melt preferably comprises 15.0 to 75.0 wt% of polypropylene (PP) and/or polyethylene (PE).

[0125] In some embodiments, the melt furthermore comprises polyvinyl chloride (PVC), wherein the melt preferably comprises 15.0 to 75.0 wt% of polyvinyl chloride (PVC).

[0126] In some embodiments, the melt furthermore comprises a blowing agent. This produces pores in the spacer and makes a reduction in weight of the spacer of approx. 20% to as much as 50% possible.

[0127] In some embodiments, the blowing agent comprises CO₂ and/or N₂, or with the blowing agent forming CO₂ and/or N₂ during extrusion.

[0128] In some embodiments, the melt furthermore comprises a filler, preferably 20.0 to 90.0 wt%, more preferably 20.0 to 80.0 wt% of filler, with the filler preferably comprising chalk. In some embodiments, the melt comprises 20.0 to 40.0 wt% of chalk, for example 25.0 to 35.0 wt% of chalk, for example 30.0 wt% of chalk.

[0129] In some embodiments, the melt comprises 5.0 to 65.0 wt% of polyvinyl butyral (PVB); 15.0 to 75.0 wt% of polypropylene (PP) and/or polyethylene (PE); and up to 80 wt% of filler.

[0130] In some embodiments, the melt comprises 20.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of PP, and up to 30.0 wt% of filler.

[0131] In some embodiments, the melt comprises 10.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of PP, and up to 30.0 wt% of filler.

[0132] In some embodiments, the melt comprises 20.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of PE, and up to 30.0 wt% of filler.

[0133] In some embodiments, the melt comprises 10.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of PE, and up to 30.0 wt% of filler.

[0134] In some embodiments, the melt comprises 5.0 to 65.0 wt% of polyvinyl butyral (PVB); 15.0 to 75.0 wt% of polyvinyl chloride (PVC); and up to 80 wt% of filler.

[0135] In some embodiments, the melt comprises 20.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of PVC, and up to 30.0 wt% of filler.

[0136] In some embodiments, the melt comprises 10.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of PVC, and up to 30.0 wt% of filler.

[0137] In some embodiments, the melt comprises 10.0 to 80.0 wt% of PVB, preferably 20.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of PP, and up to 20 wt% of filler. In some embodiments, the melt comprises 20.0 to 70.0 wt% of PVB, 30.0 to 80.0 wt% of PP, and up to 20 wt% of filler. In some embodiments, the melt comprises 20.0 to 60.0

wt% of PVB, 40.0 to 80.0 wt% of PP, and up to 20 wt% of filler. Preferably, the melt comprises 20.0 to 50.0 wt% of PVB, 50.0 to 80.0 wt% of PP, and up to 30.0 wt% of filler. In some embodiments, the melt comprises 25.0 to 45.0 wt% of PVB, 55.0 to 75.0 wt% of PP, and up to 20 wt% of filler. In some embodiments, the melt comprises 30.0 to 40.0 wt% of PVB, 60.0 to 70.0 wt% of PP, and up to 10% filler. In some embodiments, the melt comprises 32.5 to 37.5 wt% of PVB, 62.5 to 67.5 wt% of PP, and up to 5.0 wt% of filler. In some embodiments, the melt comprises 35.0 wt% of PVB and 65.0 wt% of PP.

[0138] In some embodiments, the melt comprises polyethylene (PE) and PVB, wherein the melt comprises 10.0 to 80.0 wt%, 20.0 to 80.0 wt%, 20.0 to 70.0 wt%, 20.0 to 60.0 wt%, 20.0 to 50.0 wt%, or 25.0 to 45.0 wt%, or 30.0 to 40.0 wt%, or 32.5 to 37.5 wt%, or 35.0 wt% of PVB. In some embodiments, the melt comprises 20.0 to 80.0 wt%, 30.0 to 80.0 wt%, 40.0 to 80.0 wt%, 50.0 to 80.0 wt%, or 55.0 to 75.0 wt%, or 60.0 to 70.0 wt%, or 62.5 to 67.5 wt%, or 65.0 wt% of PE. Optionally, the melt comprises up to 30 wt% of filler.

[0139] In some embodiments, the melt comprises 10.0 to 80.0 wt% of PVB, preferably 20.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of PE, and up to 30 wt% of filler. In some embodiments, the melt comprises 20.0 to 70.0 wt% of PVB, 30.0 to 80.0 wt% of PE, and up to 30 wt% of filler. In some embodiments, the melt comprises 20.0 to 60.0 wt% of PVB, 40.0 to 80.0 wt% of PE, and up to 30 wt% of filler. In some embodiments, the melt comprises 20.0 to 50.0 wt% of PVB, 50.0 to 80.0 wt% of PE, and up to 30 wt% of filler. In some embodiments, the melt comprises 25.0 to 45.0 wt% of PVB, or 55.0 to 75.0 wt% of PE, and up to 20 wt% of filler. In some embodiments, the melt comprises 30.0 to 40.0 wt% of PVB, 60.0 to 70.0 wt% of PE, and up to 10% filler. In some embodiments, the melt comprises 32.5 to 37.5 wt% of PVB, 62.5 to 67.5 wt% of PE, and up to 5.0 wt% of filler. In some embodiments, the melt comprises 35.0 wt% of PVB and 65.0 wt% of PE.

[0140] In some embodiments, the melt comprises polyvinyl chloride (PVC) and PVB, with the melt comprising 20.0 to 80.0 wt%, or 20.0 to 70.0 wt%, or 20.0 to 60.0 wt%, or 20.0 to 50.0 wt%, or 25.0 to 45.0 wt%, or 30.0 to 40.0 wt%, or 32.5 to 37.5 wt%, or 35.0 wt% of PVB. In some embodiments, the melt comprises 20.0 to 80.0 wt%, or 30.0 to 80.0 wt%, or 40.0 to 80.0 wt%, or 50.0 to 80.0 wt%, or 55.0 to 75.0 wt%, or 60.0 to 70.0 wt%, or 62.5 to 67.5 wt%, or 65.0 wt% of PVC. Optionally, the melt comprises up to 20 wt% or up to 30 wt% of filler.

[0141] In some embodiments, the melt comprises 10.0 to 80.0 wt% of PVB, preferably 20.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of PVC, and up to 20 wt% of filler. In some embodiments, the melt comprises 20.0 to 70.0 wt% of PVB, 30.0 to 80.0 wt% of PVC, and up to 20 wt% of filler. In some embodiments, the melt comprises 20.0 to 60.0 wt% of PVB, 40.0 to 80.0 wt% of PVC, and up to 20 wt% of filler. In some embodiments, the melt comprises 20.0 to 50.0 wt% of PVB, 50.0 to 80.0 wt% of PVC, and up to 30 wt% of filler. In some embodiments, the melt

comprises 25.0 to 45.0 wt% of PVB, or 55.0 to 75.0 wt% of PVC, and up to 20 wt% of filler. In some embodiments, the melt comprises 30.0 to 40.0 wt% of PVB, 60.0 to 70.0 wt% of PVC, and up to 10% of filler. In some embodiments, the melt comprises 32.5 to 37.5 wt% of PVB, 62.5 to 67.5 wt% of PVC, and up to 5.0 wt% of filler. In some embodiments, the melt comprises 35.0 wt% of PVB and 65.0 wt% of PVC.

[0142] In some embodiments, the plastic having elastomeric properties comprises recycled plastic having elastomeric properties, preferably the PP comprises recycled PP, preferably the PE comprises recycled PE, preferably the PVC comprises recycled PVC, preferably the PVB comprises recycled PVB.

[0143] In some embodiments, the PVC comprises foamed PVC.

[0144] In some embodiments, a method is provided for producing a spacer as provided herein which furthermore comprises one or more of the following steps:

- pulling the cooled-down spacer preform;
- piercing holes in the sides and/or base of the spacers;
- punching the spacers;
- packaging the resulting spacers in a packaging station.

[0145] Piercing may take place before or after sawing or cutting. This may be performed both in-line and offline.

[0146] Preferably, the sawing off or cutting off the spacer preform is performed in-line.

[0147] In some embodiments, no additional stabilizer is added during a method for producing a spacer as provided herein. Alternatively, the methods for producing a spacer as provided herein comprise the step of adding a stabilizer to the melt. An example of a stabilizer is a UV stabilizer.

[0148] In some embodiments, 1 to 16, or 1 to 8, or 1 to 6, or 1 to 4, for example 2 to 3, spacers are extruded simultaneously. The more spacers are extruded simultaneously, the higher the production rate. However, this also renders subsequent punching out more difficult.

[0149] In some embodiments, the extrusion is performed at a rate of 1.0 to 18.0 m/min, or at a rate of 1.0 to 15.0 m/min, or at a rate of 2.0 to 9.0 m/min, or at a rate of 3.0 to 8.0 m/min, or at a rate of 4.0 to 7.0 m/min, or at a rate of 5.0 to 6.0 m/min, or at a rate of 10.0 to 18.0 m/min.

[0150] The use of extrusion has the advantage that small contaminations in the raw material are acceptable. This is very advantageous when working with recycled PP and PVB, as these recycled raw materials typically contain impurities. Optionally, the PP / PVB mixture is filtered before extrusion. This increases the resistance of the extrusion process against impurities, so that recycled raw materials of inferior quality may be used.

[0151] Preferably, plastic is supplied to the mould by means of a screw. The plastic is melted in the screw to form a melt which is then extruded.

[0152] In some embodiments, the method comprises the use of a calibration tool to check the shape and dimensions of the spacer preform.

[0153] As has already been mentioned, it is alternatively also possible to use injection-moulding instead of extrusion in order to produce the spacers as described herein. Thus, this document provides a method for producing a spacer as described herein, the method comprising the following steps:

- injection-moulding a melt to form a spacer, wherein the melt comprises polyvinyl butyral.

[0154] Preferably, the melt has a composition as described herein in the context of the extrusion method. Preferably, a spacer having a composition as described herein is thus formed.

EXAMPLES

[0155] The present invention is illustrated further by means of the following non-limiting examples.

Example 1

[0156] In a first example, reference is made to Fig. 1. Fig. 1 comprises two panels a) and b) which each show a spacer (100) with a U-shaped cross section.

[0157] The spacer (100) shown in panel a) comprises side faces (120) (also referred to as flanges) which are closed. In other words, the side faces (120) of the spacer in panel a) do not comprise any openings and the edge of the side faces (120) runs continuously in a substantially straight line. This spacer (100) with a closed shape is very suitable for use with a soft surface or materials such as insulation.

[0158] The spacer (100) shown in panel b) comprises openings (125) in its side faces (120). These openings (125) are connected to the edge of the side faces (120) and cause the edge of the side faces (120) to have an undulating profile. Providing openings (125) in the side faces (120) reduces the weight of the spacer (100) per unit length. This spacer is highly suitable for use between a reinforcement cage and a formwork.

[0159] Both the spacer (100) shown in panel a) and that shown in panel b) comprise openings (115) in their base (110). This reduces the weight of the spacers per unit length.

[0160] The spacers from Fig. 1 comprise polyvinyl butyral, polypropylene, and optionally filler, in particular 20.0 to 80.0 wt% of recycled PVB, 20.0 to 80.0 wt% of recycled PP, and up to 30.0 wt% of filler. The filler comprises chalk.

Example 2

[0161] By way of further example, reference is made to Fig. 2 which shows how spacers (100) can be placed

around a reinforcement cage (200) in order to ensure a minimum distance between the reinforcement cage and the formwork. The spacer is elongate, comprises a base surface, two side faces and has a U-shaped cross section. By cutting the side faces, the spacer can be curved in corners.

[0162] In this way, a high-quality construction of reinforced concrete can be produced, in which the strong and light spacers assist in achieving an easy installation and a high-quality end product.

[0163] In particular, the construction of reinforced concrete is produced by providing one or more spacers and placing a reinforcement cage. The one or more spacers comprise 20.0 to 80.0 wt% of recycled PVB, 20.0 to 80.0 wt% of recycled PP, and up to 30 wt% of chalk. Subsequently, the reinforcement cage is positioned using the one or more spacers and concrete is poured over the reinforcement cage and spacers (100). The concrete then sets, so that a construction made of reinforced concrete is obtained which comprises the reinforcement cage (200) and the spacers (100).

Example 3

[0164] By way of further example, reference is made to Fig. 3 and a method for producing a spacer as provided herein is described.

[0165] The method comprises supplying plastic which comprises polyvinyl butyral, polypropylene, blowing agent and chalk to a screw (2) by means of a hopper (1). In the screw (2), the plastic is melted to form a melt. The melt comprises 20.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of PP, and up to 30.0 wt% of chalk. As an alternative to chalk, it is possible, for example, to use calcium carbonate, kaolin, magnesium hydroxide, glass, wollastonite or titanium dioxide. The PVB comprises recycled PVB and the PP comprises recycled PP. Subsequently, the melt is extruded by a die (3) to form a spacer preform. A calibration tool (4) provides a vacuum and a constant and correct shape. Then, the preform is cooled by means of a cooler (5) using cold water. A pulling mechanism ensures that the cooled-down preforms are pulled along and supplied to a device for sawing and piercing (7) where the cooled-down preforms are sawn to a desired length, and where holes are pierced in their bases and sides. This is followed by packaging of the resulting spacers (100) in a packaging station (8).

Example 4

[0166] In a further example, reference is made to Fig. 4. This figure shows two form factors of elongate spacers (100).

[0167] In particular, panel a) shows spacers which comprise a base (110) and two side faces (120). The side faces (120) are at an angle with respect to the base (110) and make an obtuse angle α of approx. 95° to 175°, for example 120°, with the latter. These spacers (100)

can easily be stacked on top of each other without becoming jammed together. In particular, stable stacks can be formed in which successive spacers (100) have an identical orientation.

[0168] Panel b) also shows spacers which comprise a base (110) and two side faces (120). The side faces (120) are perpendicular to the base (110), in other words, they form a right angle α with the latter. These spacers (100) can easily be stacked on top of each other without becoming jammed together. In particular, stable stacks can be formed in which successive spacers (100) are rotated through 180° with respect to each other.

[0169] These spacers have a composition as described herein.

Example 5

[0170] As a further example, reference is made to Fig. 5. This figure shows two alternative shapes for a spacer. In particular, panel a) from Fig. 5 shows a ring-shaped spacer (100) and panel b) from Fig. 5 shows a star-shaped spacer (100). These spacers may be produced, for example, by means of injection-moulding.

[0171] These spacers have a composition as described herein.

Example 6

[0172] As a further example, reference is made to any of the Examples 1 to 5 and to Figs. 1 to 5, in which the spacer (100) is based on PVB and PE rather than PVB and PP.

[0173] In particular, according to this example, the spacers shown in Fig. 1 and described in Example 1 comprise polyvinyl butyral (PVB), polyethylene (PE), and optionally filler, in particular 20.0 to 80.0 wt% of recycled PVB, 20.0 to 80.0 wt% of recycled PE, and up to 30.0 wt% of filler. The filler comprises chalk. According to this example, the spacers shown in Fig. 2 and described in Example 2 comprise 20.0 to 80.0 wt% of recycled PVB, 20.0 to 80.0 wt% of recycled PE, and up to 30 wt% of chalk. It is possible to use, for example, calcium carbonate, kaolin, magnesium hydroxide, glass, wollastonite or titanium dioxide as an alternative for chalk.

[0174] According to this example, the method for producing a spacer is virtually identical to the method described in Example 3, except that the melt comprises 20.0 to 80.0 wt% of PVB, 20.0 to 80.0 wt% of PE, and up to 30.0 wt% of chalk.

[0175] The spacers described in Examples 4 and 5 may also be based on PVB and PE, for example having the compositions mentioned above.

Example 7

[0176] As a further example, reference is made to any of the Examples 1 to 5 and to Figs. 1 to 5, in which the spacer (100) is based on PVB and PVC rather than PVB

and PP.

[0177] In particular, according to this example, the spacers shown in Fig. 1 and described in Example 1 comprise polyvinyl butyral (PVB), polyvinyl chloride (PVC), and optionally filler, in particular 20.0 to 80.0 wt% of recycled PVB, 20.0 to 80.0 wt% of recycled PVC, and up to 30.0 wt% of filler. The filler comprises chalk.

[0178] According to this example, the spacers shown in Fig. 2 and described in Example 2 comprise 20.0 to 80.0 wt% of recycled PVB, 20.0 to 80.0 wt% of recycled PVC, and up to 30 wt% of chalk. It is also possible, for example, to use calcium carbonate, kaolin, magnesium hydroxide, glass, wollastonite or titanium dioxide as an alternative to chalk.

[0179] According to this example, the method for producing a spacer is identical to the method described in Example 3, except that the melt comprises 20.0 to 50.0 wt% of PVB, 50.0 to 80.0 wt% of PVC, and up to 30.0 wt% of chalk.

[0180] The spacers described in Examples 4 and 5 may also be based on PVB and PVC, for example having the compositions mentioned above.

Example 8

[0181] As a further example, the properties of spacers which comprised recycled foamed PVC and PVC micro-nisate in combination with recycled PVB (Fig. 6 D, E, F and G) were compared with those of commercially available spacers (Fig. 6 A, B and C). The tensile-strength tests, bending tests and pressure tests showed that the measured tensile strength, bending force, flowing point and E-modulus of the respective tests were better or at least equal to those of the commercially available spacers. In addition, it was found that the use of foamed PVC in combination with between 5 wt% of and 20 wt% of recycled PVB (Fig. 6D) results in significantly improved properties.

Claims

1. Method for producing a construction made of reinforced concrete, comprising the following steps:

- providing one or more spacers (100);
- providing a reinforcement cage (200), a concrete mesh or a lattice girder;
- positioning the reinforcement cage (200) by means of the one or more spacers;
- pouring concrete over the reinforcement cage (200), the concrete mesh or the lattice girder, on the one hand, and the one or more spacers (100), on the other hand;
- allowing the concrete to set;

wherein the one or more spacers (100) comprise a plastic having elastomeric properties selected from

a thermoplast, a thermoset and/or an elastomer, the spacers preferably comprising 10.0 to 80.0 wt%, more preferably 20.0 to 80.0 wt% of plastic having elastomeric properties.

2. Method according to Claim 1, wherein a thermoplast is selected from polyvinyl chloride (PVC), polypropylene (PP), polyethylene (PE), polystyrene (PS) and/or polyvinyl butyral (PVB), wherein a thermoset is selected from bakelite, polyurethane resin, polyester, silicone and/or epoxy, and/or wherein an elastomer is selected from a thermoplastic elastomer, such as synthetic rubber, and/or a thermosetting elastomer, such as natural rubber.
3. Method according to Claim 1 or 2, wherein the one or more spacers (100) comprise polyvinyl butyral (PVB), wherein the spacers preferably comprise 5.0 to 60.0 wt% of polyvinyl butyral (PVB).
4. Method according to any of Claims 1 to 3, wherein the one or more spacers furthermore comprise polypropylene (PP) and/or polyethylene (PE), wherein the spacers preferably comprise 15.0 to 75.0 wt% of polypropylene (PP) and/or polyethylene (PE).
5. Method according to any of Claims 1 to 3, wherein the one or more spacers furthermore comprise polyvinyl chloride (PVC), wherein the spacers preferably comprise 15.0 to 75.0 wt% of polyvinyl chloride (PVC).
6. Method according to any of Claims 1 to 5, wherein the one or more spacers furthermore comprise filler, preferably comprise 20.0 to 80.0 wt% of filler, with the filler preferably comprising chalk.
7. Method according to any of Claims 1 to 4 and 6, wherein the spacers (100) comprise 5.0 to 65.0 wt% of polyvinyl butyral (PVB); comprise 15.0 to 75.0 wt% of polypropylene (PP) and/or polyethylene (PE); and comprise up to 80 wt% of filler.
8. Method according to any of Claims 1 to 3 and 5 to 6, wherein the spacers (100) comprise 5.0 to 65.0 wt% of polyvinyl butyral (PVB); comprise 15.0 to 75.0 wt% of polyvinyl chloride (PVC); and comprise up to 80 wt% of filler.
9. Method according to any of Claims 1 to 8, wherein the plastic having elastomeric properties comprises recycled plastic having elastomeric properties, preferably wherein the PP comprises recycled PP, preferably wherein the PE comprises recycled PE, preferably wherein the PVC comprises recycled PVC, preferably wherein the PVB comprises recycled PVB.

10. Method according to any of Claims 1 to 3 and 5 to 9, wherein the PVC comprises foamed PVC.
11. Method according to any of Claims 1 to 10, wherein the spacer (100) is elongate, comprises a base surface, comprises two side faces and has a U-shaped cross section. 5
12. Spacer (100) for reinforcement bars in a construction made of reinforced concrete which comprises a plastic having elastomeric properties selected from a thermoplast, a thermoset and/or an elastomer, wherein the spacers preferably comprise 10.0 to 80.0 wt%, preferably 20.0 to 80.0 wt% of plastic having elastomeric properties. 10
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13. Spacer (100) according to Claim 12, produced according to a method according to any of Claims 1 to 11. 20
14. Method for producing a spacer (100) according to any of Claims 12 or 13, the method comprising the following steps: 25
- extruding a melt to form to form a spacer preform, wherein the melt comprises a plastic having elastomeric properties selected from a thermoplast, a thermoset and/or an elastomer, preferably wherein a thermoplast is selected from polyvinyl chloride (PVC), polypropylene (PP), polyethylene (PE), polystyrene (PS) and/or polyvinyl butyral (PVB), wherein a thermoset is selected from bakelite, polyurethane resin, polyester, silicone and/or epoxy, and/or wherein an elastomer is selected from a thermoplastic elastomer, such as synthetic rubber, and/or a thermosetting elastomer, such as natural rubber, and preferably comprises polyvinyl butyral, with the melt preferably comprising 5.0 to 60.0 wt% of polyvinyl butyral (PVB); 30
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 - cooling the spacer preform;
 - sawing off or cutting off the spacer preform, thereby forming a spacer (100).
15. Method for producing a spacer (100) according to any of Claims 12 or 13, the method comprising the following steps: 45
- injection-moulding a melt to form a spacer, wherein the melt comprises a plastic having elastomeric properties selected from a thermoplast, a thermoset and/or an elastomer, preferably wherein a thermoplast is selected from polyvinyl chloride (PVC), polypropylene (PP), polyethylene (PE), polystyrene (PS) and/or polyvinyl butyral (PVB), wherein a thermoset is selected from bakelite, polyurethane resin, polyester, silicone and/or epoxy, and/or wherein an elas- 50
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tomers is selected from a thermoplastic elastomer, such as synthetic rubber, and/or a thermosetting elastomer, such as natural rubber and preferably comprises polyvinyl butyral, with the melt preferably comprising 5.0 to 60.0 wt% of polyvinyl butyral (PVB).

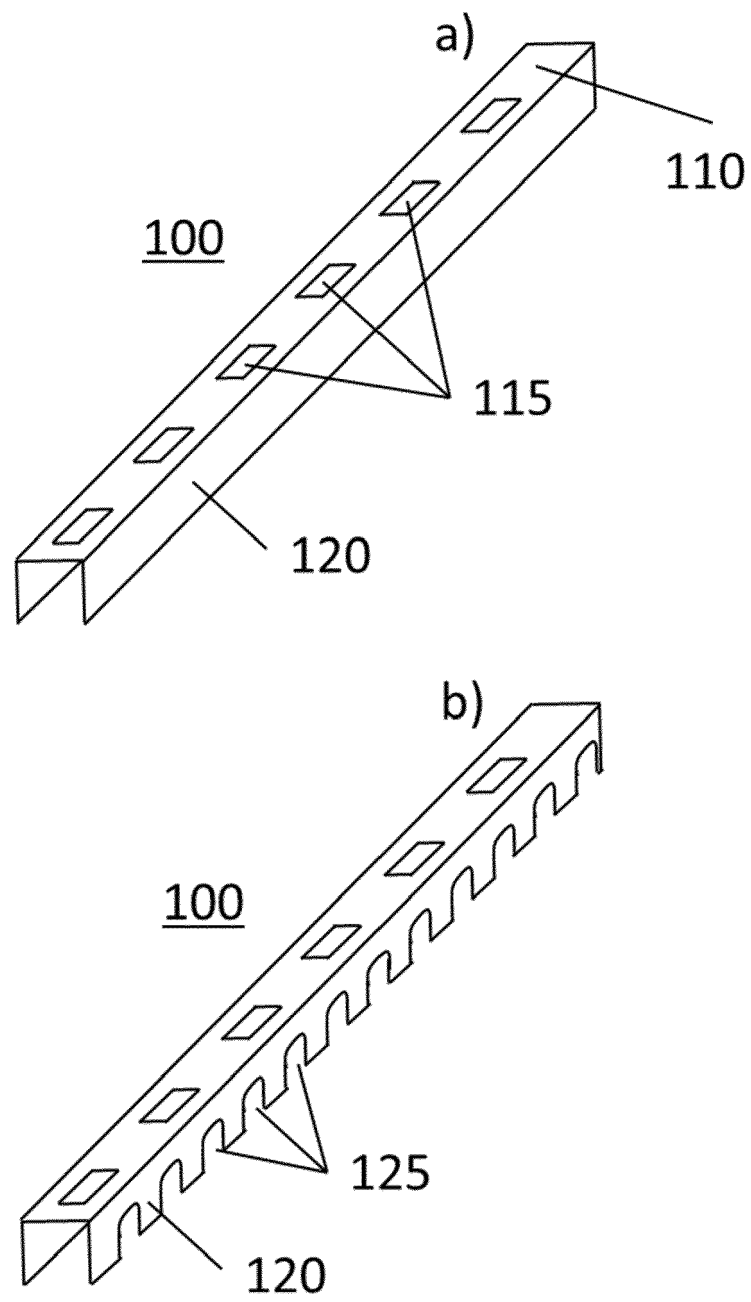


Fig. 1

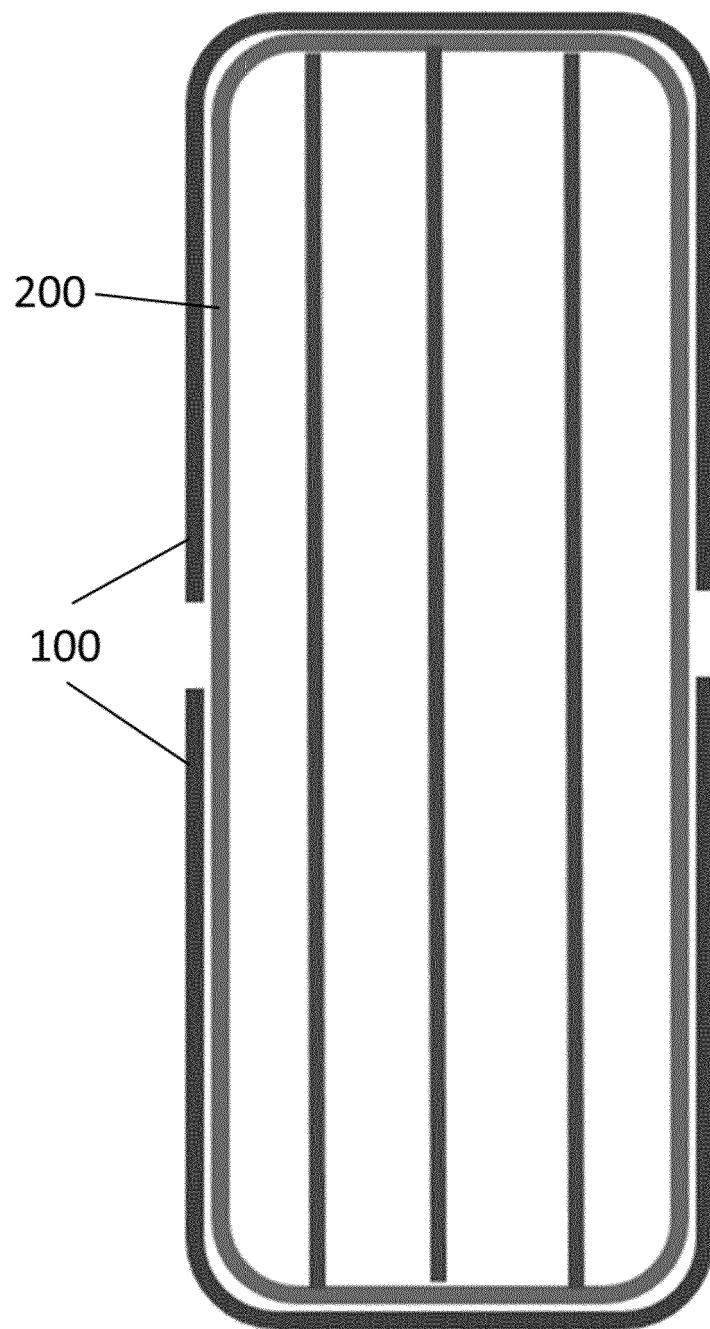


Fig. 2

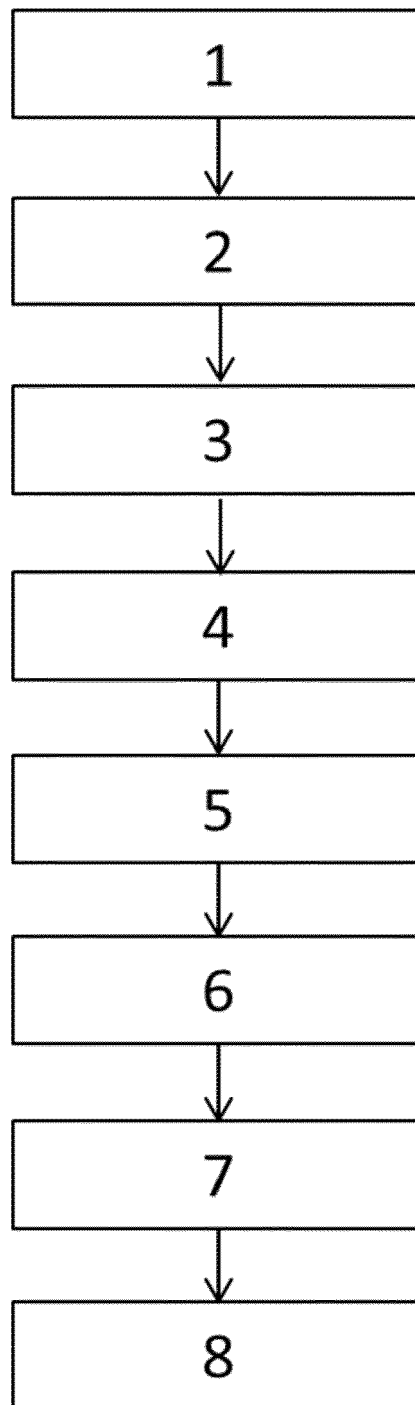


Fig. 3

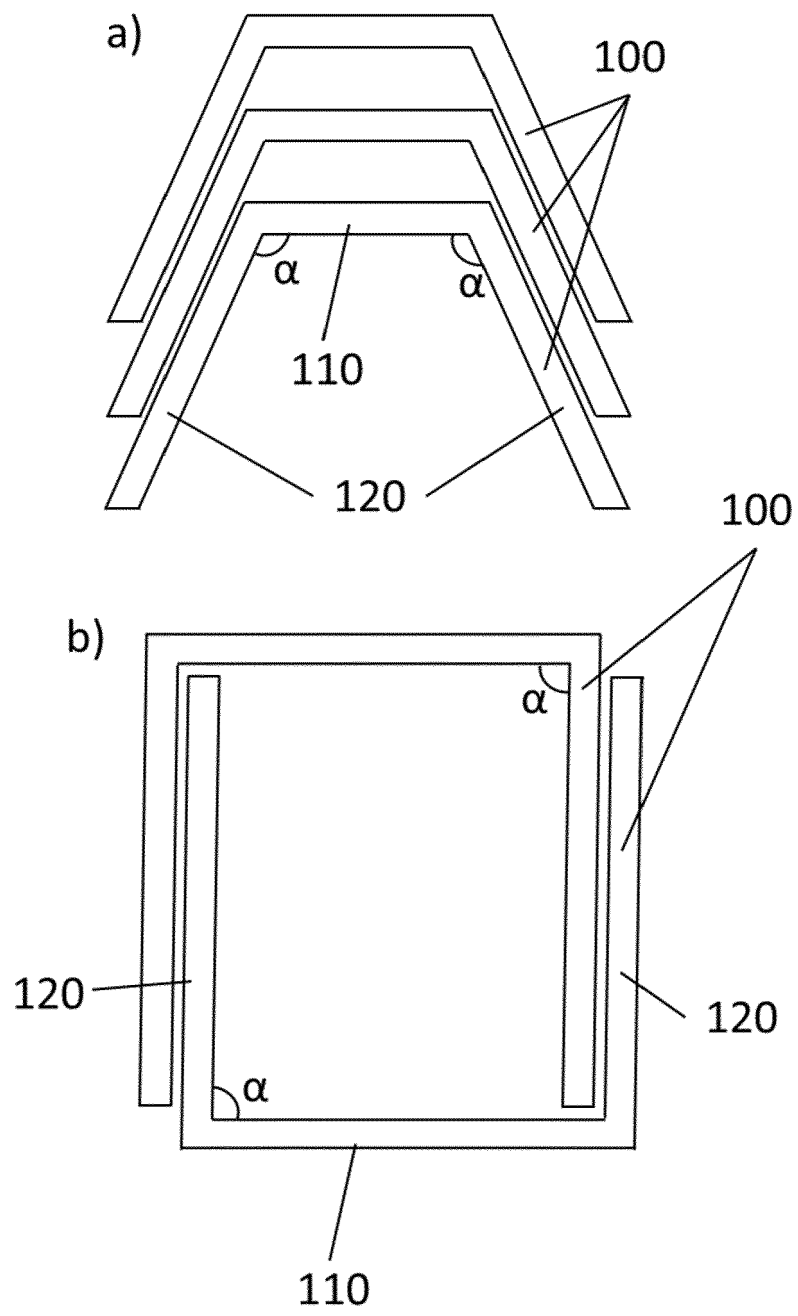


Fig. 4

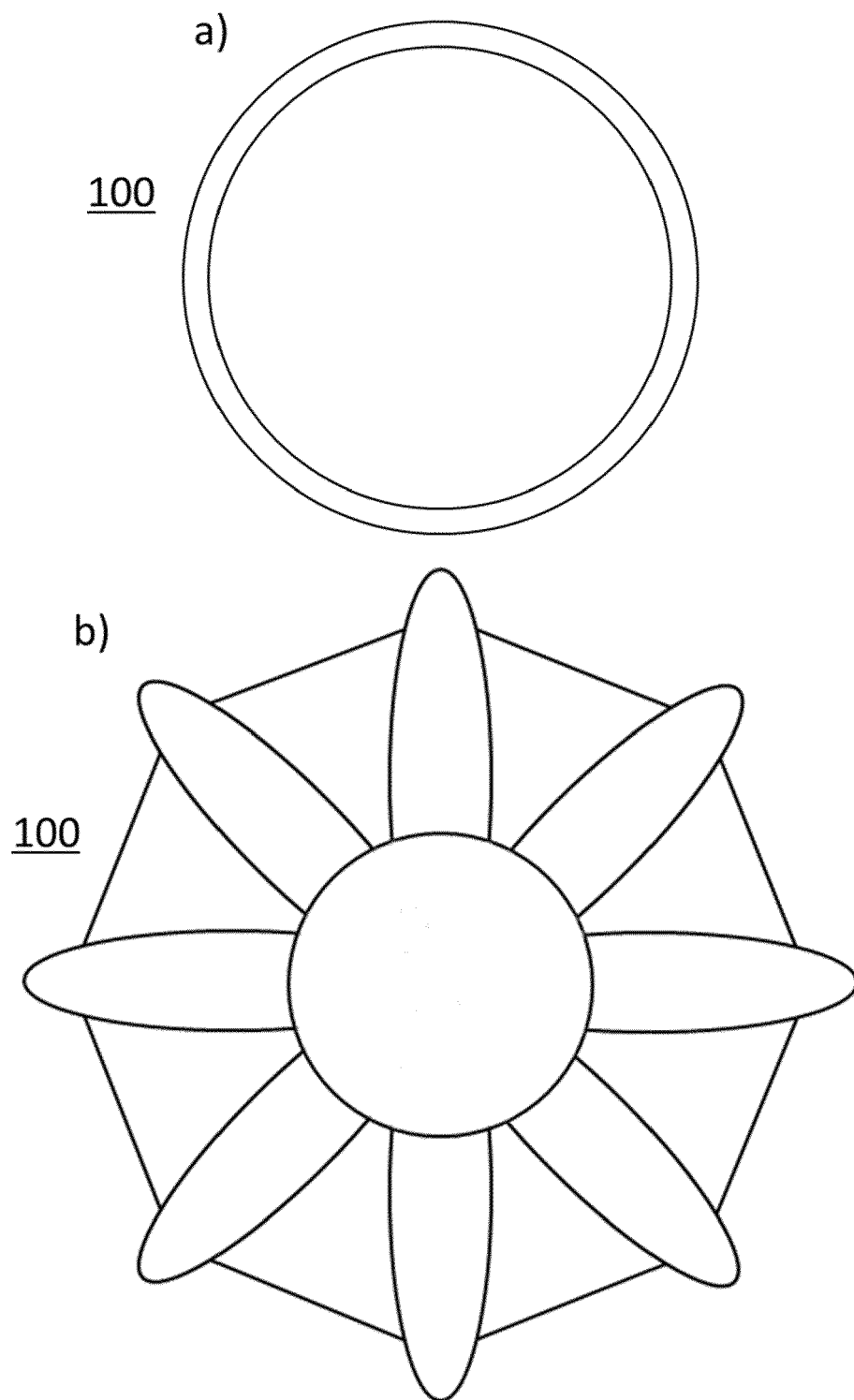


Fig. 5

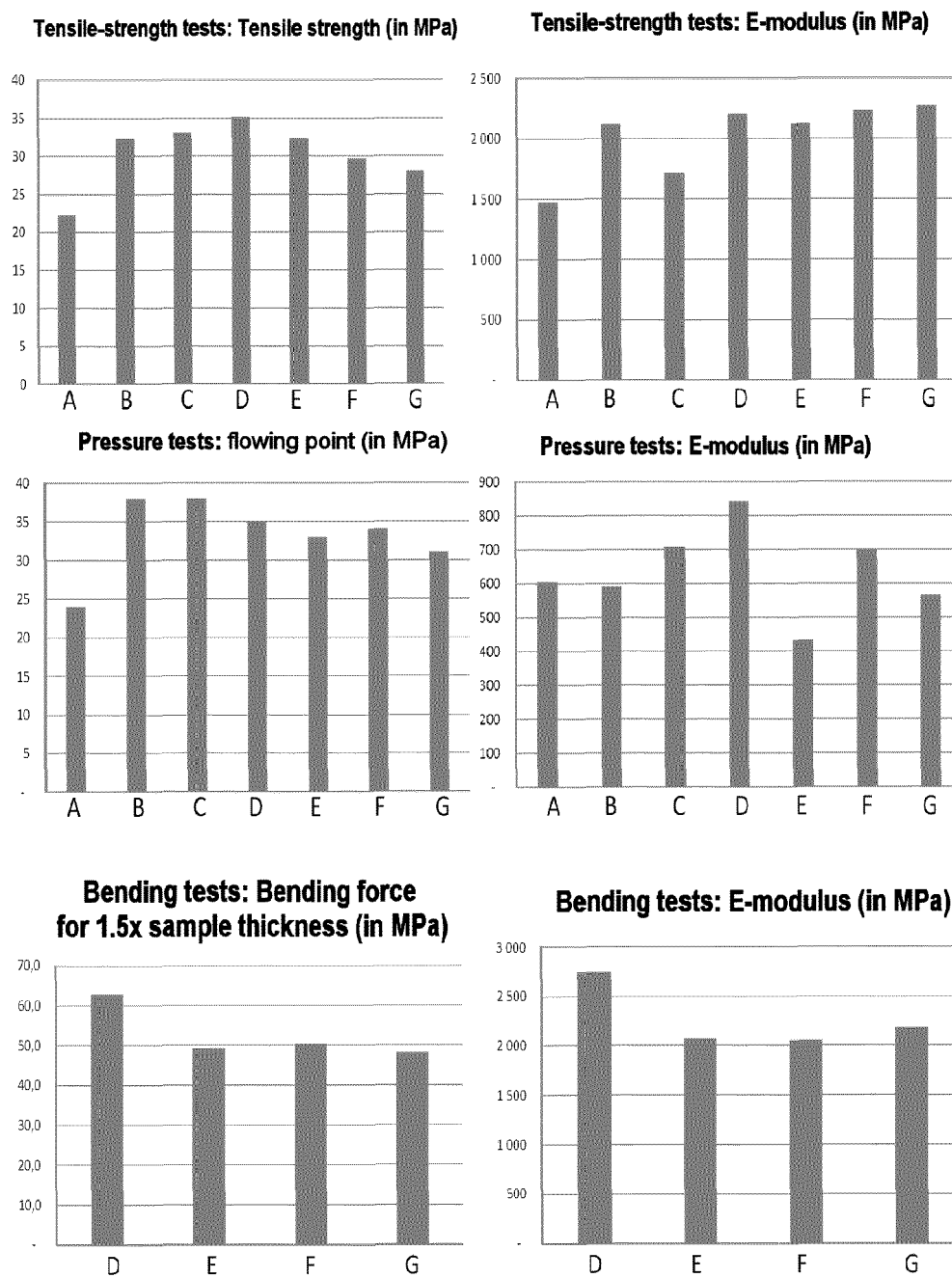


Fig. 6



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			E04C
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 22 December 2020	Examiner Righetti, Roberto
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