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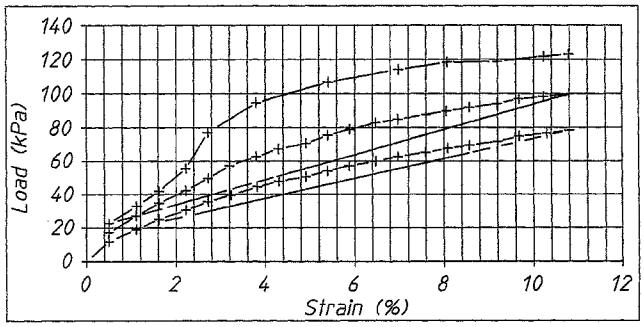
(54) **Title:** RUBBER COMPOSITE FOR USE IN A SURFACE



Wet Density (t/m³)	0.92	Sample supplied by the client
Remarks: The specimen was tested as received. Three load cycles were performed on the one specimen.		

(57) **Abstract:** A rubber composite comprising a) rubber; b) an aggregate material; c) optionally, a filler; d) a bituminous material; and e) a lightweight material. The method of producing the rubber composite comprises the steps of a) dry mixing rubber, an aggregate material, a lightweight material and optionally a filler; b) adding water to the dry mixture; and c) adding a bituminous material.

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TITLE

RUBBER COMPOSITE FOR USE IN A SURFACE

FIELD OF THE INVENTION

This invention relates to rubber composites, methods and applications therefor. In particular, this invention relates to rubber composites for use in surfaces. This invention also relates to a method of producing rubber composites and a method of producing surfaces or blocks. The surface may be used for many applications including but not limited to stabilisation of soil and/or sand, a substrate for the growing of grasses, plants, shrubs and trees, linings for sloped surfaces and retaining walls, weatherproof tracks for sporting and recreational events (including racetracks, sportsgrounds, playgrounds), gardens, parks, walking and running paths, wall units, paving blocks, floor surfaces, linings, artificial and natural turf or pitches for homes, buildings and outdoor locations. Particular applications include cricket pitches, tennis courts, sub surface drains, swales for trapping surface debris, rooftop gardens, construction roofing for waterproofing, insulation and sound absorption, internal refitted slabs for noise reduction on freeways, range of uses for equestrian sports from yards and arenas to facilities for training.

SUMMARY OF THE INVENTION

Throughout this specification, unless the context clearly indicates otherwise, the word "comprise", "comprises", "comprising" or other variations thereof shall be understood as meaning that the stated integer is included and does not exclude other integers from being present even though those other integers are not explicitly stated.

According to an embodiment of this invention, there is provided a rubber composite comprising:

a) rubber;

b) an aggregate material;

c) optionally, a filler;

d) a bituminous material; and

e) a lightweight material.

The rubber composite may be adapted to be laid on a surface or formed into a block.

According to an embodiment of this invention, there is provided a rubber composite for a surface comprising:

a) rubber;

b) an aggregate material;

c) optionally, a filler;

d) a bituminous material; and

e) a lightweight material.

According to another embodiment of this invention, there is provided a rubber composite for a surface consisting essentially of:

a) rubber;

b) an aggregate material;

c) optionally, a filler;

d) a bituminous material; and

e) a lightweight material.

According to a further embodiment of this invention, there is provided a rubber composite for a surface consisting of:

a) rubber;

b) an aggregate material;

c) optionally, a filler;

d) a bituminous material; and

e) a lightweight material.

According to a further embodiment of this invention, there is provided a rubber composite for a block comprising:

a) rubber;

b) an aggregate material;

c) optionally, a filler;

d) a bituminous material; and

e) a lightweight material.

According to a further embodiment of this invention, there is provided a rubber composite for a block consisting essentially of:

a) rubber;

b) an aggregate material;

c) optionally, a filler;

d) a bituminous material; and

e) a lightweight material.

According to a further embodiment of this invention, there is provided a rubber composite for a block consisting of:

a) rubber;

b) an aggregate material;

c) optionally, a filler;

d) a bituminous material; and

e) a lightweight material.

According to a further embodiment of this invention, there is provided a surface made of a rubber composite comprising:

a) rubber;

b) an aggregate material;

c) optionally, a filler;

d) a bituminous material; and

e) a lightweight material.

According to a further embodiment of this invention, there is provided a surface made of a rubber composite consisting essentially of:

a) rubber;

b) an aggregate material;

c) optionally, a filler;

d) a bituminous material; and

e) a lightweight material.

According to a further embodiment of this invention, there is provided a surface made of a rubber composite consisting of:

a) rubber;

b) an aggregate material;

c) optionally, a filler;

d) a bituminous material; and

e) a lightweight material.

The surface may be a natural or an artificial surface. The surface may be a weatherproof track for sporting and recreational events. In particular, the surface may include a surface for a racetrack, a sportsground, a playground, a natural turf or pitch for homes, buildings and outdoor locations.

The block may be a block for use in the landscaping, construction and the building industry. Some examples include a paving block comprising the rubber

composite of the present invention and which may be adapted for use in laying paths, tracks, walls or covering soil.

The surface may be a racetrack, sports track, block form, pathway or the like.

According to a further embodiment of this invention, there is provided a surface made of a rubber composite comprising:

a) rubber;

b) an aggregate material;

c) optionally, a filler;

d) a bituminous material; and

e) one or more foams.

According to a further embodiment of this invention, there is provided a surface made of a rubber composite consisting essentially of:

a) rubber;

b) an aggregate material;

c) optionally, a filler;

d) a bituminous material; and

e) one or more foams.

According to a further embodiment of this invention, there is provided a surface made of a rubber composite consisting of:

a) rubber;

b) an aggregate material;

c) optionally, a filler;

d) a bituminous material; and

e) one or more foams.

In a further embodiment, the rubber composite comprises:

a) about 5wt% to about 95wt% rubber;

b) about 5 wt% to about 95wt% of an aggregate material;

c) optionally, about 0.5wt% to about 50wt% of a filler;

d) about 5wt% to about 95wt% of a bituminous material; and

e) about 0.1 wt% to about 75 wt% of a lightweight material.

In yet a further embodiment of the present invention, the rubber composite comprises:

a) about 5wt% to about 85wt% rubber;

b) about 5 wt% to about 85wt% of an aggregate material;

c) optionally, about 0.5wt% to about 35wt% of a filler;

d) about 5wt% to about 85wt% of a bituminous material; and

e) about 0.1 wt% to about 60 wt% of a lightweight material.

In yet a further embodiment of the present invention, the rubber composite comprises:

a) about 5wt% to about 75wt% rubber;

b) about 5 wt% to about 75wt% of an aggregate material;

c) optionally, about 0.5wt% to about 25wt% of a filler;

d) about 5wt% to about 75wt% of a bituminous material; and

e) about 0.1 wt% to about 50 wt% of a lightweight material.

In yet a further embodiment of the present invention, the rubber composite comprises:

a) about 5wt% to about 50wt% rubber;

b) about 5 wt% to about 50wt% of an aggregate material;

c) optionally, about 2.5wt% to about 15wt% of a filler;

d) about 10wt% to about 45wt% of a bituminous material; and

e) about 0.5 wt% to about 30 wt% of a lightweight material.

In yet a further embodiment of the present invention, the rubber composite comprises:

a) about 10wt% to about 30wt% rubber;

b) about 25 wt% to about 50wt% of an aggregate material;

c) optionally, about 0.5wt% to about 10wt% of a filler;

d) about 10wt% to about 30wt% of a bituminous material; and

e) about 1.0 wt% to about 10 wt% of a lightweight material.

In yet a further embodiment of the present invention, the rubber composite comprises:

a) about 15wt% to about 25wt% rubber;

b) about 35 wt% to about 45wt% of an aggregate material;

c) optionally, about 2.5wt% to about 7.5wt% of a filler;

d) about 15wt% to about 25wt% of a bituminous material; and

e) about 2.5 wt% to about 7.5 wt% of a lightweight material.

In a further embodiment of the rubber composite of the present invention, there is provided a rubber composite comprising:

a) about 20wt% to about 25wt% rubber;

b) about 40 wt% to about 45wt% of an aggregate material;

c) optionally, about 3.0wt% to about 6.0wt% of a filler;

d) about 20wt% to about 25wt% of a bituminous material; and

e) about 3.05 wt% to about 6.0 wt% of a lightweight material.

The bituminous material may include bitumen, asphalt, tar, pitch and a bitumen/polymer emulsion.

The rubber may be recycled or natural rubber and may be derived from the shredding of tyres. The shredded rubber may be in the form of granules or fragments of rubber which may be formed from waste tyres. The rubber may have a grading analysis of from about 1 to about 50 mesh, from about 2 to about 45 mesh, from about 3 to about 40 mesh, from about 4 to about 35mesh, from about 5 to about 30 mesh, from about 6 to about 25mesh, from about 6 to about 20 mesh, from about 7 to about 15 mesh, and from about 7 to about 14 mesh. In particular, the rubber may be crumb rubber.

The aggregate material may be a porous aggregate material. The aggregate material may be a silicate mineral, an aluminosilicate mineral, a slag or other lightweight porous material including fly ash, sand, crushed concrete or stone, pumice and other volcanic or ash products. In particular, the silicate mineral may be selected from the group consisting of blast furnace slag, concrete sand, basalt, fly ash, crusher dust, crushed blue metal (volcanic basalt), crushed recycled brick, brick dust, crushed sandstone, course sand, vermiculite, and dolomite. The aggregate material may have cementitious properties and may be resistant to heat and weathering.

The aggregate material may also be shaped and may be of a specific particle size of less than about 10mm, about 9.5mm, about 9.0mm, about 8.5mm, about 8.0mm, about 7.5mm, about 7.0mm, about 6.5mm, about 6.0mm, about 5.5mm, about 5.0mm, about 4.5mm, about 4.0mm, about 3.5mm, about 3.0mm, about 2.5mm, about 2.0mm, about 1.5mm and less, which includes particles sieved to fines which are approximately 1 mm and lower so that the aggregate particles have an interlocking shape. The crushed recycled brick may include brick with a particle size of less than about 5mm, about 4.5mm, about 4.0mm, about 3.5mm, about 3.0mm, about 2.5mm, less than about 2.0mm, or less than about 1.5mm.

The filler may be soil, cement dust, natural pozzolans such as diatomaceous earth, opaline shale, pumicite, tuff, or artificial pozzolans such as fly ash.

The bituminous material may be an asphalt containing composition or a polymer modified bitumen emulsion. The polymer may be latex and the bitumen may be cationic.

The bitumen/polymer emulsion may be water based. The bitumen/polymer emulsion may be formulated to set rapidly. In one example, the setting times of the bitumen/polymer emulsion may be up to about 10 minutes, up to about 9 minutes, up to

about 8 minutes, up to about 7 minutes, up to about 6 minutes, up to about 5 minutes, up to about 4 minutes, up to about 3 minutes, up to about 2 minutes, and up to about 1 minute. The bitumen/polymer emulsion may have adhesion capabilities and low viscosity.

The bituminous material content of the bitumen/polymer in one embodiment may be about 50wt% to about 99wt%, about 55wt% to about 99wt%, about 60wt% to about 99wt%, about 65wt% to about 99wt%, about 70wt% to about 99wt%, about 75wt% to about 99wt%, about 80wt% to about 99wt%, about 85wt% to about 99wt%, about 90wt% to about 99wt%, about 95wt% to about 99wt%, and about 97.5wt% to about 99wt%.

The consistency of the bitumen/polymer in one embodiment may be about 20cp to about 99cp, about 25 to about 99cp, about 30cp to about 99cp, about 35cp to about 95cp, about 40cp to about 90cp, about 45cp to about 85cp, about 50cp to about 80cp, about 55cp to about 75cp, about 60cp to about 70cp, about 62cp to about 68cp, about 63cp to about 68cp, about 64cp to about 68cp and about 65cp to about 68cp.

The light weight material may be one or more shaped lightweight polymeric products, lightweight fibrous material, straw, sawdust and the like. The lightweight polymeric products may be lightweight shaped polymeric products selected from the group consisting of polystyrene, a cellulose polymer, or cork, fibre glass, rayon shreds, nylon shreds, recycled plastic/plastic shreds, foam, carbon fibres, polyester fibres, polypropylenes, cotton fibres, wool fibres or mixtures thereof.

The lightweight polystyrene may be polystyrene shaped balls, polystyrene fibres or the polystyrene may be particulate in shape. The polystyrene shaped balls may be of a diameter size of from 0.5 to about 5mm, about 1.0 to about 5mm, about 1.5 to about 4.5mm, about 2.0 to about 4.0mm, about 2.5 to about 3.5mm, about 3.0 to about 5.0mm, about 3.0 to about 4.5mm, and about 3.0 to about 4.0mm. The polystyrene may also be present in other shapes such as flat sheets of up to about 5mm, 4.5mm, 4.0mm, 3.5mm, 3.0mm, or up to about 2.5mm. The polystyrene may also be present in the rubber composite as a lattice structure or any other structure which allows for water to permeate between the polystyrene particles.

In a particular embodiment, the lightweight material may be foam. The foam may be selected from foamed concrete, foamed polymeric materials and other foam products which are lightweight, durable and suitable to be mixed with the rubber composite of the present invention. The foamed polymeric material may be polyurethane foam, polystyrene foam, polyolefin foam, PVC foam, epoxy foam, silicone foam, and

phenolic foam. The foam may be pre-made foam or formed in the rubber composite *in situ*. The foam may be in the form of pieces having a diameter of from about 0.5 to about 5mm, about 1.0 to about 5mm, about 1.5 to about 4.5mm, about 2.0 to about 4.0mm, about 2.5 to about 3.5mm, about 3.0 to about 5.0mm, about 3.0 to about 4.5mm, and about 3.0 to about 4.0mm. The foam may also be present in other shapes such as flat sheets of up to about 5mm, 4.5mm, 4.0mm, 3.5mm, 3.0mm, or up to about 2.5mm. The foam may also be present in the rubber composite as a lattice structure or any other structure which allows for water to permeate between the foam pieces.

In one embodiment of the present invention, the lightweight material may be a mixture of foam and polystyrene balls, polystyrene particles or fibres. The ratio of foam: polystrene balls, particles or fibres may be in the wt:wt range of 1:50, 2:50, 3:50, 4:50, 5:50, 6:50, 7:50, 8:50, 9:50, 10:50, 11:50, 12:50, 13:50, 14:50, 15:50, 16:50, 17:50, 18:50, 19:50, 20:50, 21:50, 22:50, 23:50, 24:50, 25:50, 26:50, 27:50, 28:50, 29:50, 30:50, 31:50, 32:50, 33:50, 34;50, 35:50, 36:50, 37:50, 38:50, 39:50, 40:50, 41:50, 42:50, 43:50, 44:50. 45:50, 46:50, 47:50, 48:50, 49:50, 50:50, 50: 49, 50:48, 50:47, 50:46, 50:45, 50:44, 50:43, 50:42, 50:41, 50:40, 50:39, 50:38, 50:37, 50:36, 50:35, 50:34, 50;33, 50:32, 50:33, 50:32, 50:31, 50:30, 50:29, 50:28, 50:27, 50:26, 50:25, 50:4 24, 50:23, 50:22, 50:21, 50:20, 50:19, 50:18, 50:17, 50:16, 50;15, 50:14, 50:13, 50:12, 50:11, 50:10, 50:9, 50:8, 50:7, 50:6, 50:5, 50:4, 50:3, 50:2 or 50:1.

One or more foaming agents in the form of additives may be introduced into the rubber composite mixture in liquid form with dosage ranges from about 50mls to about 150mls per cubic metre, about 55mls to about 145mls per cubic metre, about 60mls to about 140mls per cubic metre, about 70mls to about 130mls per cubic metre, about 80 mls to about 120 mls per cubic metre, about 90mls to about 110mls per cubic metre, and about 100mls to about 105mls per cubic metre. The variances in the dosage range of the additive will influence the rise in volume but as an example, adding about 120 mls in the rubber composite mix will increase the volume by about 22 to about 25%. Accordingly, this leads to a reduction in the overall weight of the finished product by this amount. Some examples of suitable foaming agents which may be an additive include the commercial product CellFlow which is a synthetic liquid anionic biodegradable concentrate formulated for the production of low density rigid foams. Dilute aqueous solutions of the foaming agent are readily converted to voluminous stable microbubbled air foams with a precisely controlled density. There are a number of mechanical foaming devices known in the art to produce the foam.

Pre Made Foam may be obtained by mixing in a maxi flow generator aided by a standard air compressor. Rates again vary depending upon the amount of volume desired but a standard to achieve 50% weight reduction in a cubic metre is approximately 500 foam litres. Examples of pre made foam include the commercial product Mearlcrete which is an aqueous concentrate of a surface active polypeptide-alkylene polyol condensate specially formulated to yield a tough, stable, voluminous micro bubbled foam.

The preferred method for producing foam products is to uniformly blend the air foam with aqueous slurries or suspensions or reactive inorganic solids. Alternatively the air cells may be formed by mixing the slurry (in a specific example, the dry materials plus water) then adding a small amount as described above of the concentrated foaming agent. In any event, after the slurry is foamed the homogenous mix becomes rigid after reacting with the water, retaining the uniform cellular bubble structure.

According to a further embodiment of this invention, there is provided a rubber composite for a surface or block comprising:

a) recycled or natural rubber;

b) an aggregate material;

c) optionally, a filler;

d) a bituminous material; and

e) a lightweight material which is preferably one or more shaped lightweight polymeric products.

According to a further embodiment of this invention, there is provided a rubber composite for a surface or block consisting essentially of:

a) recycled or natural rubber;

b) an aggregate material;

f) optionally, a filler;

g) a bituminous material; and

h) a lightweight material which is preferably one or more shaped lightweight polymeric products.

According to a further embodiment of this invention, there is provided a rubber composite for a surface or block consisting of:

a) recycled or natural rubber;

b) an aggregate material;

i) optionally, a filler;

j) a bituminous material; and

k) a lightweight material which is preferably one or more shaped lightweight polymeric products.

In a particular example, the aggregate material is a porous aggregate material and may be blast furnace slag or concrete sand. The blast furnace slag or concrete sand is a non-metallic product comprising silicates and aluminosilicates of calcium.

The blast furnace slag may have a sizing of up to 10.0mm, 9.5mm, 9.0mm, 8.5mm, 8.0mm, 7.5mm, 7.0mm, 6.5mm, 6mm, up to 5.75mm, up to 5.5mm, up to 5.25mm, up to 5.0mm, up to 4.75mm, up to 4.5mm, up to 4.25mm, up to 4.0mm, up to 3.75mm, up to 3.5mm, up to 3.25mm, up to 3.0mm, up to 2.75mm, up to 2.5mm, up to 2.25mm, up to 2.0mm, up to 1.75mm, up to 1.5mm, up to 1.25mm, up to 1.0mm, up to 0.75mm, up to 0.5mm, and up to 0.25mm.

It is to be understood by the person skilled in the art that components a) to e) may be present in various weight percentage ranges and some examples of specific weight percentage ranges for components a) to e) are as follows.

The rubber of component a) of the rubber composite of the present invention may be present in w/w% range of the total weight of the rubber composite comprising components a) to e) as follows:

about 5wt% to about 95wt%;
about 5wt% to about 90 wt%;
about 5wt% to about 85 wt%;
about 5wt% to about 80 wt%;
about 5wt% to about 75 wt%;
about 5wt% to about 70 wt%;
about 5wt% to about 65 wt%;
about 5wt% to about 60 wt%;
about 5wt% to about 55 wt%;
about 5wt% to about 50 wt%;
about 10 wt% to about 45wt%;
about 10wt% to about 42.5wt%;
about 10 wt% to about 40wt%;
about 10wt% to about 37.5wt%;
about 10wt% to about 35wt%;
about 10wt% to about 32.5wt%;
about 10wt% to about 30.0 wt%;
about 12.5wt% to about 27.5wt%;

about 12.5wt% to about 25.0wt%;
about 12.5wt% to about 25.0wt%;
about 15.0wt% to about 25.0wt%;
about 17.5wt% to about 25.0wt%;
about 20.0wt% to about 25.0wt%;
and about 22.5wt%.

The aggregate material of component b) of the rubber composite of the present invention may be present in w/w% range of the total weight of the rubber composite comprising components a) to e) as follows:

about 5wt% to about 95wt%;
about 5wt% to about 90 wt%;
about 5wt% to about 85 wt%;
about 5wt% to about 80 wt%;
about 5wt% to about 75 wt%;
about 10wt% to about 70 wt%;
about 15wt% to about 65 wt%;
about 20wt% to about 60 wt%;
about 25wt% to about 55 wt%;
about 30wt% to about 50 wt%;
about 30 wt% to about 50wt%;
about 32.5wt% to about 47.5wt%;
about 35 wt% to about 47.5wt%;
about 37.5wt% to about 47.5wt%;
about 40.0wt% to about 45.0wt%;
and about 42.5wt%.

The optional filler material of component c) of the rubber composite of the present invention may be present in w/w% range of the total weight of the rubber composite comprising components a) to e) as follows:

about 0.5wt% to about 50wt%;
about 0.5wt% to about 45 wt%;
about 0.5wt% to about 40 wt%;
about 0.5wt% to about 35 wt%;
about 0.5wt% to about 30 wt%;
about 1.0wt% to about 25 wt%;
about 1.5wt% to about 20 wt%;

about 2.0wt% to about 17.5 wt%;
about 2.5wt% to about 15.0wt%;
about 3.0wt% to about 12.5wt%;
about 3.5wt% to about 10.0wt%;
about 4.0wt% to about 7.5wt%wt%;
about 4.0wt% to about 6.0wt%; and
about 5.0wt%.

The bituminous material of component d) of the rubber composite of the present invention may be present in w/w% range of the total weight of the rubber composite comprising components a) to e) as follows:

about 5wt% to about 95wt%;
about 5wt% to about 90 wt%;
about 5wt% to about 85 wt%;
about 5wt% to about 80 wt%;
about 5wt% to about 75 wt%;
about 10wt% to about 70 wt%;
about 10wt% to about 65 wt%;
about 10wt% to about 60 wt%;
about 10wt% to about 55 wt%;
about 10wt% to about 50 wt%;
about 10 wt% to about 45wt%;
about 12.5wt% to about 40wt%;
about 15 wt% to about 35wt%;
about 15wt% to about 27.5wt%;
about 15wt% to about 25.0wt%;
about 17.5wt% to about 25.0wt%;
about 20.0wt% to about 25.0wt%;
and about 23.0wt%.

The lightweight material of component e) of the rubber composite of the present invention may be present in w/w% range of the total weight of the rubber composite comprising components a) to e) as follows:

about 0.1wt% to about 75wt%;
about 0.1wt% to about 70 wt%;
about 0.1wt% to about 65 wt%;
about 0.1wt% to about 60 wt%;

about 0.1wt% to about 55 wt%;
about 0.5wt% to about 50 wt%;
about 0.5wt% to about 45wt%;
about 0.5wt% to about 40 wt%;
about 0.5wt% to about 35 wt%;
about 0.5wt% to about 30 wt%;
about 1.0wt% to about 25 wt%;
about 1.5wt% to about 20 wt%;
about 2.0wt% to about 17.5 wt%;
about 2.5wt% to about 15.0wt%;
about 3.0wt% to about 12.5wt%;
about 3.5wt% to about 10.0wt%;
about 4.0wt% to about 7.5wt%wt%;
about 4.0wt% to about 6.0wt%; and
about 5.0wt%.

In another embodiment of the present invention, the rubber composite may comprise up to about 5wt% water, or up to 4.5wt% water, up to 4.0wt% water, up to 3.5wt% water, up to 3.0wt% water, up to 2.5wt% water, up to 2.0wt% water, up to 1.5wt% water, up to 1.0wt% water, up to 0.5wt% water, and up to 0.25wt% water. The rubber composite may comprise from 0.1wt% up to about 5wt% water, or from 0.1wt% up to 4.5wt% water, from 0.1wt% up to 4.0wt% water, from 0.1wt% up to 3.5wt% water, from 0.1wt% up to 3.0wt% water, from 0.1wt% up to 2.5wt% water, from 0.1wt% up to 2.0wt% water, from 0.1wt% up to 1.5wt% water, from 0.1wt% up to 1.0wt% water, from 0.1wt% up to 0.5wt% water, from 0.1wt% up to 0.25wt% water, from 0.2wt% up to about 5wt% water, or from 0.2wt% up to 4.5wt% water, from 0.2wt% up to 4.0wt% water, from 0.2wt% up to 3.5wt% water, from 0.2wt% up to 3.0wt% water, from 0.2wt% up to 2.5wt% water, from 0.2wt% up to 2.0wt% water, from 0.2wt% up to 1.5wt% water, from 0.2wt% up to 1.0wt% water, from 0.2wt% up to 0.5wt% water, and from 0.2wt% up to 0.25wt% water.

The rubber composite of the present invention in at least the preferred embodiments of the present invention may provide a superior bond with high tensile strength, fire resistance and high durability. In particular, it is believed that the aggregate material and rubber may form a superior bond with high tensile strength, fire resistance and high durability.

The rubber composite may have a bulk density (loose) of from about 0.7 to 1.5t/m^3, about 0.75 to 1.45t/m^3, about 0.8 to 1.4t/m^3, about 0.85 to 1.35t/m^3, about 0.9 to 1.3t/m^3, about 0.9 to 1.25t/m^3, about 0.9 to 1.20t/m^3, about 0.9 to 1.15t/m^3, about 0.9 to about 1.1t/m^3, about 0.9 to 1.05t/m^3, about 0.9 to 1.0t/m^3, about 0.9 to 0.950t/m^3, and about 0.9 to about 0.930t/m^3.

The rubber composite may have water absorption rates of about 1.0% to about 40.0%, about 1.5% to about 39.5%, about 2.0% to about 39.0%, about 2.5% to about 38.5%, about 3.0% to about 38.0%, about 3.5% to about 37.5%, about 4.0% to about 37.0%, about 4.5% to about 36.5%, about 5.0% to about 36.0%, about 5.5% to about 35.5%, about 6.0% to about 35.0%, about 6.5% to about 34.5%, about 7.0% to about 34.0%, and about 7.5% to about 33.5%, about 8.0% to about 33.0%, about 8.5% to about 32.5%, about 9.0% to about 32.0%, about 9.5% to about 31.5%, about 10.0% to about 31.0%, about 10.5% to about 30.5% , about 11.0% to about 30.0%, about 11.5% to about 29.5%, about 12.0% to about 29.0% , about 12.5% to about 28.5%, about 13.0% to about 28.0%, about 13.5% to about 27.5%, about 14.0% to about 27.0%, about 14.5% to about 26.5%, about 15.0% to about 26.0%, about 15.5% to about 25.5%, about 16.0% to about 25.0%, about 16.5% to about 24.5%, about 17.0% to about 24.0%, about 17.5% to about 23.5%, about 18.0% to about 23.0%, about 18.5% to about 22.5%, about 19.0% to about 22.0%, about 19.5% to about 21.5%, about 19.5% to about 21.0%, about 19.5% to about 20.5%, and about 20.0%.

The rubber composite may have a saturated hydraulic conductivity in the range from about 500 to about 6000mm/hour, from about 600 to about 5900mm/hour, from about 700 to about 5800mm/hour, from about 800 to about 5700mm/hour, from about 900 to about 5600mm/hour, from about 1000 to about 5500mm/hour, from about 1200 to about 5400mm/hour, from about 1400 to about 5300mm/hour, from about 1600 to about 5200mm/hour, from about 1800 to about 5100mm/hour, from about 2000 to about 5000mm/hour, from about 2200 to about 5000mm/hour, from about 2200 to about 5000mm/hour, from about 2400 to about 5000mm/hour, from about 2600 to about 5000mm/hour, from about 2800 to about 5000mm/hour, from about 3000 to about 4900mm/hour, from about 3200 to about 4900mm/hour, from about 3400 to about 4900mm/hour, from about 3600 to about 4900mm/hour,and from about 2500 to about 4800mm/hour.

The saturated hydraulic conductivity relates to the flow rate of water through the medium i.e. its drainage capacity.

According to a further embodiment of this invention, there is provided a method of producing a rubber composite comprising the steps of:

- adding rubber to an aggregate material and optionally, a filler;
- adding a lightweight material which is preferably one or more shaped lightweight polymeric products; and
- adding a bituminous material.

The rubber, aggregate material, filler and the lightweight material may be as described above in the specification. The bituminous material may be a polymer modified water based emulsion product.

The method of producing a rubber composite may include dry mixing the dry components comprising rubber, an aggregate material, a filler, a lightweight material in a suitable mixer. The mixer may be a pugmill/blender/mixer. The step of mixing may occur for a suitable period of time until the dry mixture is thoroughly mixed. The step of mixing may include more than one mixing step.

After the mixing step of the dry components, water may be added to the mixture until the mixture is damp. Further additions of water may be added in a suitable amount to ensure suitable dampness and to ensure the mixture is homogenous. The water may be added in amount of between about 0.25 to about 4 litres, about 0.5 to about 3.5 litres, about 1.0 to about 3.0 litres, and about 2 litres. Water may be added in an amount up to about 25wt% water, up to about 20wt% water, up to about 15wt% water, up to about 10wt% water, up to about 7.5wt% water, up to about 5wt% water, or up to 4.5wt% water, up to 4.0wt% water, up to 3.5wt% water, up to 3.0wt% water, up to 2.5wt% water, up to 2.0wt% water, up to 1.5wt% water, up to 1.0wt% water, up to 0.5wt% water, and up to 0.25wt% water. The rubber composite may comprise from 0.1wt% up to about 5wt% water, or from 0.1wt% up to 4.5wt% water, from 0.1wt% up to 4.0wt% water, from 0.1wt% up to 3.5wt% water, from 0.1wt% up to 3.0wt% water, from 0.1wt% up to 2.5wt% water, from 0.1wt% up to 2.0wt% water, from 0.1wt% up to 1.5wt% water, from 0.1wt% up to 1.0wt% water, from 0.1wt% up to 0.5wt% water, from 0.1wt% up to 0.25wt% water, from 0.2wt% up to about 5wt% water, or from 0.2wt% up to 4.5wt% water, from 0.2wt% up to 4.0wt% water, from 0.2wt% up to 3.5wt% water, from 0.2wt% up to 3.0wt% water, from 0.2wt% up to 2.5wt% water, from 0.2wt% up to 2.0wt% water, from 0.2wt% up to 1.5wt% water, from 0.2wt% up to 1.0wt% water, from 0.2wt% up to 0.5wt% water, and from 0.2wt% up to 0.25wt% water.

The bitumen/polymer emulsion is then added to the damp mixture and may be blended again for a suitable period of time in one or more separate steps until the resulting mixture is flowable and substantially homogenous to form a flowable mixture.

The flowable mixture may be shaped into suitably shaped moulds for casting. The mould may be block shaped or shaped for any other application. The flowable mixtures may then be levelled off and may be left to be cured at ambient temperature.

The method may be a continuous process.

In another embodiment, the flowable rubber composite mixture may be made on site by using modified concrete mixers, blenders, road building machines, and further comprise pumping the flowable mixture to a desired surface or location.

According to a further embodiment of this invention, there is provided a method of producing a rubber composite comprising the steps of:

- adding rubber to an aggregate material and optionally a filler;
- adding a lightweight material which is preferably one or more foams; and
- adding a bituminous material.

In this embodiment, the method of producing a rubber composite may include dry mixing the dry components comprising rubber, aggregate material, and filler in a suitable mixer. The mixer may be a pugmill/blender/mixer. The step of mixing may occur for a suitable period of time until the dry mixture is thoroughly mixed. The step of mixing may include more than one mixing step.

A foaming agent may be introduced into the homogenous mixture and blended for a suitable period of time. Water may be added to maintain the workability of the flowable mixture. Suitable dosages of the foaming agent may be from about 50mls to about 150mls per cubic metre, about 60mls to about 140mls per cubic metre, about 70mls to about 130mls per cubic metre, about 80 mls to about 120 mls per cubic metre, about 90mls to about 110mls per cubic metre, and about 100mls to about 105mls per cubic metre. The variances in the dosage range of the additive will influence the rise in volume but as an example, adding about 120 mls in the rubber composite mix will increase the volume by about 22 to about 25%. Accordingly, this leads to a reduction in the overall weight of the finished product by this amount.

The bitumen/polymer emulsion is then added to the damp mixture and may be blended again for a suitable period of time in one or more separate steps until the resulting mixture is flowable and substantially homogenous to form a flowable mixture.

The flowable mixture may be shaped into suitably shaped moulds for casting as described previously.

Suitable optional additives and/or fillers which are used in the rubber composite and methods of this invention include additional aggregates, thickeners, microfillers and fillers, air entraining agents, extenders, strength enhancers, plasticisers, surfactants, dispersion agents, anti-slip agents, corrosion inhibitors, ultraviolet (UV) light absorbing agents, fire retardants, and the like. These additives may be added at any stage of the above method.

The foam in cellular form may be formed from agents which are used to form lightweight foamed concrete. The foam introduces stable air bubbles within the slurry matrix of the rubber composite mixture prior to pouring into molds or in situ work. Essentially, this lowers the density of the finished product without compromising the integrity of the product. Some of the foams are readily available commercially, some are proprietary. The foam is made using a simple generator where air, water and the foaming agent are mixed and a stable foam is formed. This is then introduced into the rubber composite of the present invention and mixed with the slurry prior to expelling. The foam may constitute a very small proportion of the mix. The foam/s that may be incorporated in the mix process are commercially known as either CellFlow or Mearlcrete.

The rubber composite of the present invention may be pumpable or sprayable which allows for applications such as pumping the rubber composite on to suitable surfaces and to permit stabilisation of soils, sands, loose stones, rocks, gravel, and the like. The pumping of the rubber composite of the present invention allows for the rubber composite to be used in golf bunker applications in a similar manner to free formed or pre formed concrete. The pumping of the rubber composite also allows the rubber composite to be poured into trenches for agricultural use as drains or soil substitutes.

According to further embodiment of this invention, there is provided a method of spraying or pumping a rubber composite of the present invention onto a substrate comprising the steps of:

- inserting a sprayable and pumpable form of the rubber composite in a pumping apparatus; and
- spraying or pumping the pumpable rubber composite onto a substrate.

The sprayable or pumpable form of the rubber composite comprises components (a) to (e) in a suitable size such that the components are able to be sprayed or pumped through the required nozzle or spray head.

The substrate may be soil, sand, a surface whether made or earth, concrete, etc. The substrate may be a floor, wall, etc. In one aspect, the rubber composite may be pumped or sprayed onto side and/or edges of sand bunkers or mounds of earth in order to

stabilise the soil and/or sand. In another aspect the method of spraying and pumping occurs at ambient temperature. For example, from about 5° to about 50°C, from about 10° to about 45°C, from about 15° to about 40°C, from about 20° to about 35°C, and from about 25° to about 30°C.

A suitable form of spraying may be the Gunnite system which is used in the manufacture of concrete sprayed swimming pools where the raw materials are released unde pressure and combine with a liquid as a spray. The use of the Gunnite system allows the formation of laminates.

According to further embodiment of this invention, there is provided a method of forming a block which is made from the rubber composite of the present invention comprising the steps of:

- producing a rubber composite of the present invention; and
- sizing the rubber composite into suitably sized blocks.

The block may be used as a paving block or sized as a larger block for use in landscaping applications, paving applications, etc.

According to a further embodiment of the present invention, there is provided a surface comprising the rubber composite of the present invention. In particular, the surface may be a track surface comprising the rubber composite of the present invention.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 is a graphical representation of the results of an Unconfined Compressive strength test performed according to AS1289 6.4.1 on an embodiment of a rubber composite of the present invention;

Figure 2 is a another graphical representation of the results of an Unconfined Compressive strength test performed according to AS1289 6.4.1 showing 3 load cycles and 2 unload cycles on the same embodiment of the rubber composite as shown in Figure 1; and

Figure 3 is a schematic flow diagram illustrating the method of production of the rubber composite as shown in Figures 1 and 2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

This invention will now be described, by way of illustration only, with reference to the following examples and figures which describe a preferred method of producing a rubber composite for use in a surface such as a racetrack. The examples and the following description of the preferred embodiment serve only to illustrate this invention

and should not be construed as limiting the generality of the disclosure of the above description.

In Figure 3, there is shown a method for producing a rubber composite in accordance with an embodiment of the present invention. The method comprises a step **(10)** which includes adding crumb rubber, an aggregate material such as blast furnace slag or concrete sand and a filler such as cement dust to form a dry mixture in a mixer. The shaped polystyrene balls are then added to the dry mixture in the mixer and the resulting mixture is blended in step **(12)** to ensure that the resulting dry mixture is thoroughly mixed and homogenous. In another embodiment, pre-made foam such as foamed concrete, foamed polystyrene or other foamed product may be blended with the polystyrene balls in a ratio of 1:10 to 10:1 and specifically the ratio of premade foam to polystyrene balls may be 1:10, 2:10, 3:10, 4:10, 5:10, 6:10, &:10, 8:10, 9:10, 10:10, 10:9, 10:8, 10:7, 10:6, 10:5, 10:4, 10:3, 10:2 or 10:1. Alternatively, the pre-made foam may be substituted for the polystyrene balls in the dry rubber mixture. Water is then added to the mixer to form a dampened rubber mixture. In another embodiment, the foam may be formed in the dry rubber mixture by adding a foaming agent to form foam *in situ*. The foaming agent may be added after the addition of water to the mixer in order to form foam *in situ*.

A bitumen/polymer emulsion is then added to the dampened mixture in the mixer before another mixing step **(14)** is conducted to form a flowable rubber composite mixture. The blending is conducted for a period of time until a consistent flowable rubber composite mixture is formed.

In step **(16)** of the method of the present invention, the consistent flowable rubber mixture is discharged into suitably shaped cast moulds (not shown) at ambient temperature. The consistent flowable rubber mixture is allowed to cure in the shaped cast moulds to form a rubber composite at ambient temperature and may be levelled off as required. In step **(16)**, the step of shaping the rubber composite in one embodiment is by way of a utilising a batching plant comprising storage bins, load cells, hoppers, augers, conveyor belts, and planetary mixing machines with drops where the rubber composite is weighed for quality control and product analysis. The consistent flowable rubber composite mixture is poured into a number of precast moulds. The moulds may be made of metal, plastic or cardboard. In one example of this pouring step, one unit will discharge 100kg of the consistent flowable rubber composite mixture which is poured into the precast mould and is levelled off before being conveyed by the conveyor belt to a racking system where the moulds are stored in stackable racks where the rubber

composite mixture is allowed to cure. In this example, the resulting rubber composite is in the form of a block which is 500mm x 500mm with a depth of 75mm. The shape and dimension of the rubber composite block may be easily varied by adjusting the casting moulds.

In another example, the rubber composite blocks may be made on site by using modified concrete mixers and blenders, road building machines such as pugmills and auger boxes and pumped using diaphragm pumps in a similar manner to pumping concrete.

In this manner, racetracks, pavements and surfaces can be formed by either using the pumping of the flowable rubber composite mixture or by using the preformed block product.

EXAMPLES

Example 1

A rubber composite was prepared having the following components (all units are in kg unless otherwise specified)

Crumb Rubber	22.50
Minerals (Concrete Sand Blend or Blast Furnace slag)	44.50
Filler (Cement Dust)	5.0
Shaped lightweight material (Polystyrene balls)	5.0
Water	up to 2 litres
Bitumen/Polymer emulsion	23 litres

The Bitumen/polymer emulsion is a polymer modified water based bitumen emulsion product, (CAS No. 8052-42-4). Butanol may be added to the bitumen/polymer emulsion which assists in tensile strength. It can be manufactured or purchased at any number of suppliers and is a generic term. The chemical composite of the bitumen/polymer emulsion comprises bitumen which includes predominantly high-molecular weight organic compounds with carbon numbers greater than C25 and high carbon to hydrogen ratios, with amines and performance additives in a mixture of kerosene, hydrochloric acid and water.

The above-mentioned dry mix components of the composite of this example is pre-blended in a pugmill/blender/mixer for approximately 30 to 40 seconds. The dry mix components are inspected and examined for thorough mixing and if appropriate the dry mix components are blended again.

After the blend is thoroughly mixed, the dry mix components are blended with water until the mixture is slightly damp and of a slightly darker colour. If required, further amounts of water can be added up to 2 litres. The damp mixture is blended again for about 30 seconds. The mixture is inspected to ensure that the mixture is homogenous.

The bitumen/polymer emulsion is then added and the resulting mixture is blended again for about 30 to 60 seconds. The blending process may be stopped at any time during this period for examination without destabilising the formula.

After the mixture is consistent and flowable, the resulting mixture can be discharged into suitably shaped moulds for casting.

The process for shaping the rubber composite includes a stand alone batching plant which comprises storage bins, load cells, hoppers, augers, conveyor belts, planetary mixing machines with drops where the rubber composite is weighed for product accuracy and quality.

The consistent, flowable rubber composite mixture is poured into a number of precast metal/plastic/cardboard moulds accurately by weight. In one example, 1 unit will discharge 100 kilograms of mixed rubber composite and is levelled off before being conveyed to a racking system where it is stored vertically and allowed to cure. The process is a continuous process.

The resulting block of rubber composite is 500mm x 500mm with a depth of 75mm although these dimension may be easily varied as would be understood by those skilled in the art. The dimensions may be varied according to different applications and sizings required.

In another process, the blocks of rubber composite may be made on site by using modified concrete mixers and blenders, standard road building machines such as pugmills and auger boxes and pumped using diaphragm pumps which are similar to concrete pumps. In another process, the flowable rubber composite may be poured into a cubic frame with a series of internal leaves, where the leaves are able to be separated when the product is cured. Sizes may vary from 500mm x 500mm with a depth of 75mm as required.

Pavements, racetracks and the like may be made by either using the block product (in a similar manner to paving blocks) or by pouring the flowable, liquid rubber polymer composite on site as required.

The properties of pavements, racetracks and the like which are made from the rubber composite of the present invention(by way of block or by pouring on site) may be measured as follows:

Impact Tolerance:	30-80gmax rating
Saturated Hydraulic Conductivity:	1400-5000mm/hour
Water Holding Capacity:	15-20% by volume
Material Thickness:	100mm/75mm/50mm
Material Hardness:	iRHD Median 30-65
Rebound Resilience:	50%
Surface Traction:	25-60nm
Surface Evenness:	Standard deviation of <2mm

The following tests were conducted on the rubber composite of this example which include tests for:

- Saturated Hydraulic Conductivity
- Total Porosity
- Unconfined Compressive Strength
- Bulk Density

The tests confirm the suitability of the rubber composite for a training race course track and the results of the specific tests are set out in the accompanying Figures 1 and 2 and as shown below.

Saturated Hydraulic Conductivity relates to the flow rate of water through the medium i.e. its drainage capacity.

The test results define this rate at 4,723 mm per hour, an exceptionally quick rate of water flow. This equates to a track that is never affected by rainfall/water permitting the run through has somewhere to go. This is easily addressed by selected drainage pickups, or in the case of a 6 metre wide track internal spoon drains. This run off can be trapped if necessary, stored and then used for a variety of applications.

Total Porosity refers to the meandering network of pores within the framework of the material. Pores are varying shapes and sizes and contribute directly to the movement of water and air within the profile. The test result of 39 ensures excellent drainage capabilities, and pockets of air within the product assist in the impact absorbing qualities of the rubber composite.

Unconfined Compressive Strength is the measure in terms of a limiting resistance to deformation by a material when subjected to loading and unloading. The test performed had three cycles and two unload cycles. The results indicate that with each loading cycle the load on the sample increased at the same strain (the % amount that the specimen is compressed). The assessment of this test confirms that the sample tested became stronger

with each loading cycle. These results demonstrate that the resilience of the rubber composite in that the rubber composite absorbs compression and then springs back to its initial depth. Thus, incidence of injuries to users including humans, animals and particularly horses is dramatically reduced by cushioning the user during usage of the rubber composite. The results also demonstrate that the rubber composite can support heavy and consistent loads without damage.

Figure 1 is the graphical representation of the Unconfined Compressive Strength graphical representation of the results of an Unconfined Compressive strength test performed according to Australian Standard AS1289 6.4.1 on the rubber composite of the present example. This test demonstrates a normal standard value of compressive strength with only one pass of compression used in this test.

Figure 2 is another graphical representation of the results of an Unconfined Compressive strength test performed according to Australian Standard AS1289 6.4.1 showing the results of 3 load cycles and 2 unload cycles on the same embodiment of the rubber composite as shown in Figure 1. This test shows the strain of loading the same material over three cycles proving its stability and strength over time.

Bulk Density is simply the weight of the product when compared with soil (1.4 to 1.6 t/m3). The bulk density reading for the product was 0.95 t/m3 making it lighter than soil.

Example 2

A rubber composite was prepared having the following components (all units are in kg unless otherwise specified) which was identical to Example 1 with slight component variations for hardness, impact absorption, and acoustics. This rubber composite of this example will be used in relining walls of freeways with the medium and which comprises organic materials and plants growing thereon. To ensure the ongoing welfare of the organic materials and plants, a closed sub surface irrigation system is included, known as Renaza Rain™, which is a watering unit manufactured from recycled tyres. The irrigation system will be interspersed around the perimeter of the rubber composite and through regulators and emitters, irrigation and food supplements can be administered to the plant on a regular programme. The product will take the form of a standard block, 500 mm x 500 mm at a depth of either 75 mm of 100 mm. The blocks will be stabilised into or onto the wall surface. At the bottom of the wall a reservoir will retain and replenish the irrigation system by reticulation.

Racetracks, gardens etc. may have an overcushion of loose crumb rubber to

nominal depths of 50, 75, 100 or 150 mm. The overcushion may also include turf, soil, sand, woodchips, or other suitable organic materials.

The rubber composite may be applied as a sprayable, pourable or pumpable coating onto various substrates by way of brushing, pouring, spraying, trowelling, or rolling onto the clean substrate by manual or mechanical means. The substrates include metal, polystyrene foam, wood, cement or concrete or asphalt surfaces, soil, sand, and earth.

The advantages of the rubber composite of the present invention may be at least as follows:

- Lightweight and low density
- High tensile strength,
- Shock and sound absorbing,
- Insulation,
- Environmentally beneficial,
- Economically produced,
- Non toxic,
- Longevity,
- Little or in some cases no maintenance,
- Able to meet and exceed industry standards,
- Numerous ways to present and produce the products,
- Insect resistant, durable and hard wearing.
- Dust free.

The applications of the rubber composites, rubber blocks and coated substrates and composites and methods of this invention include:

- sports grounds, play grounds and other outdoor surfaces
- racetracks
- building products such as external walls for buildings including houses, units and other building structures including warehouses and other structures;
- paving blocks;
- gardens
- sound insulation barriers
- external panels
- internal walls, floors and ceilings for homes, portable homes, boats, ships and caravans
- stabilisation of soil and sand

- coatings for substrates

Modifications and variations such as would be apparent to a skilled addressee are deemed to be within the scope of this invention. It is also understood that the scope of this invention should not be limited to the examples illustrated above.

Claims

1. A rubber composite comprising:

a) rubber;

b) an aggregate material;

c) optionally, a filler;

d) a bituminous material; and

e) a lightweight material.

2. A rubber composite wherein the rubber is present in an amount selected from any one of the ranges: about 5wt% to about 95wt%, about 5wt% to about 90 wt%, about 5wt% to about 85 wt%, about 5wt% to about 80 wt%, about 5wt% to about 75 wt%, about 5wt% to about 70 wt%, about 5wt% to about 65 wt%, about 5wt% to about 60 wt%, about 5wt% to about 55 wt%, about 5wt% to about 50 wt%, about 10 wt% to about 45wt%, about 10wt% to about 42.5wt%, about 10 wt% to about 40wt%, about 10wt% to about 37.5wt%, about 10wt% to about 35wt%, about 10wt% to about 32.5wt%, about 10wt% to about 30.0 wt%, about 12.5wt% to about 27.5wt%, about 12.5wt% to about 25.0wt%, about 12.5wt% to about 25.0wt%, about 15.0wt% to about 25.0wt%, about 17.5wt% to about 25.0wt%, about 20.0wt% to about 25.0wt%, or about 22.5wt% in respect of components a) to e).

3. A rubber composite according to claim 1 or 2, wherein the aggregate material is present in an amount selected from any one of the ranges: about 5wt% to about 95wt%, about 5wt% to about 90 wt%, about 5wt% to about 85 wt%, about 5wt% to about 80 wt%, about 5wt% to about 75 wt%, about 10wt% to about 70 wt%, about 15wt% to about 65 wt%, about 20wt% to about 60 wt%, about 25wt% to about 55 wt%, about 30wt% to about 50 wt%, about 30 wt% to about 50wt%, about 32.5wt% to about 47.5wt%, about 35 wt% to about 47.5wt%, about 37.5wt% to about 47.5wt%, about 40.0wt% to about 45.0wt%, and about 42.5wt% in respect of components a) to e).

4. A rubber composite according to claim 1, 2 or 3, wherein the filler is present in an amount selected from any one of the ranges: about 0.5wt% to about 50wt%, about 0.5wt% to about 45 wt%, about 0.5wt% to about 40 wt%, about 0.5wt% to about 35 wt%, about 0.5wt% to about 30 wt%, about 1.0wt% to about 25 wt%, about 1.5wt% to about 20 wt%, about 2.0wt% to about 17.5 wt%, about 2.5wt% to about 15.0wt%, about 3.0wt% to

about 12.5wt%, about 3.5wt% to about 10.0wt%, about 4.0wt% to about 7.5wt%wt%, about 4.0wt% to about 6.0wt%, and about 5.0wt% in respect of components a) to e).

5. A rubber composite according to any one of claims 1 to 4, wherein the bituminous material is present in an amount selected from any one of the ranges: about 5wt% to about 90 wt%; about 5wt% to about 85 wt%; about 5wt% to about 80 wt%; about 5wt% to about 75 wt%; about 10wt% to about 70 wt%; about 10wt% to about 65 wt%; about 10wt% to about 60 wt%; about 10wt% to about 55 wt%; about 10wt% to about 50 wt%; about 10 wt% to about 45wt%; about 12.5wt% to about 40wt%; about 15 wt% to about 35wt%; about 15wt% to about 27.5wt%; about 15wt% to about 25.0wt%;about 17.5wt% to about 25.0wt%; about 20.0wt% to about 25.0wt%;and about 23.0wt% in respect of components a) to e).

6. A rubber composite according to any one of claims 1 to 5, wherein the lightweight material is present in an amount selected from any one of the ranges: about 0.1wt% to about 75wt%, about 0.1wt% to about 70 wt%, about 0.1wt% to about 65 wt%, about 0.1wt% to about 60 wt%, about 0.1wt% to about 55 wt%, about 0.5wt% to about 50 wt%, about 0.5wt% to about 45wt%, about 0.5wt% to about 40 wt%, about 0.5wt% to about 35 wt%, about 0.5wt% to about 30 wt%, about 1.0wt% to about 25 wt%, about 1.5wt% to about 20 wt%, about 2.0wt% to about 17.5 wt%, about 2.5wt% to about 15.0wt%, about 3.0wt% to about 12.5wt%, about 3.5wt% to about 10.0wt%, about 4.0wt% to about 7.5wt%, about 4.0wt% to about 6.0wt%, and about 5.0wt% in respect of components a) to e).

7. A rubber composite according to any one of the preceding claims comprising:

a) about 20wt% to about 25wt% rubber;

b) about 40 to about 45wt% of an aggregate material;

c) optionally, about 5wt% of a filler;

d) about 20wt% to about 25wt% of a bituminous material; and

e) about 5wt% of a lightweight material.

8. A rubber composite according to any one of the preceding claims, wherein the rubber is crumb rubber or rubber derived from the shredding of tyres and which has a grading analysis selected from any one of the ranges: about 1 to about 50 mesh, about 2 to about 45 mesh, about 3 to about 40mesh, about 4 to about 35 mesh, about 5 to about

30mesh, about 6 to about 25 mesh, about 6 to about 20mesh, about 7 to about 15 mesh or about 7 to about 14mesh.

9. A rubber composite according to any one of the preceding claims, wherein the lightweight material is selected from the group consisting of one or more lightweight shaped polymeric products, one or more foamed products, foamed concrete, foamed polystyrene, and mixtures thereof.

10. A rubber composite according to claim 9, wherein the lightweight shaped polymeric product is selected from polystyrene shaped balls having a diameter size in the range selected from about 0.5 to about 5mm, about 1.0 to about 5.0mm, about 1.5 to about 4.5mm, about 2.0 to about 4.0mm, about 2.5 to about 3.5mm, about 3.0 to about 5.0mm, and about 3.0 to about 4.0mm.

11. A rubber composite according to claim 9 or 10, wherein the lightweight material is a blend of polystyrene shaped balls to one or more foamed products in a ratio of from about 1:10, 2: 10, 3:10, 4:10, 5:10, 6:10, 7:10, 8:10, 9:10, 10:10, 10:9, 10:8, 10:7, 10:6, 10:5, 10:4, 10:3, 10:2, 10:1 or in a range from about 1:10 to about 10:1.

12. A rubber composite according to any one of claims 1 to 11, wherein the saturated hydraulic conductivity of the rubber composite is selected from any one of the ranges: about 500 to about 6000mm/hour, about 600 to about 5900mm/hour, about 700 to about 5800mm/hour, about 800 to about 5700mm/hour, about 900 to about 5600mm/hour, about 1000 to about 5500mm/hour, about 1200 to about 5400mm/hour, about 1400 to about 5300mm/hour, about 1600 to about 5200mm/hour, about 1800 to about 5100mm/hour, about 2000 to about 5000mm/hour, about 2200 to about 5000mm/hour, about 2200 to about 5000mm/hour, about 2400 to about 5000mm/hour, about 2600 to about 5000mm/hour, about 2800 to about 5000mm/hour, about 3000 to about 4900mm/hour, about 3200 to about 4900mm/hour, about 3400 to about 4900mm/hour, about 3600 to about 4900mm/hour, and about 2500 to about 4800mm/hour.

13. A rubber composite according to any one of claims 1 to 12, wherein the bituminous material is a water based bitumen polymer emulsion having a setting time selected from up to 10 minutes, up to 9 minutes, up to 8 minutes, up to 7 minutes, up to 6

minutes, up to 5 minutes, up to 4 minutes, up to 3 minutes, up to 2 minutes and up to 1 minute.

14. A surface comprising a rubber composite according to any one of claims 1 to 13, wherein the surface is used as a race track, sports track, pathway, playground surface, paving block, and building block.

15. A method of producing a rubber composite comprising the steps of:

a) dry mixing rubber, an aggregate material, a lightweight material and optionally a filler;

b) adding water to the dry mixture; and

c) adding a bituminous material.

16. A method according to claim 15, wherein before step c) of adding a bituminous material, water is added in an amount in one or more steps to ensure the mixture is damp and substantially homogenous.

17. A method according to claim 15 or 16, wherein after step c), the resulting flowable and substantially homogenous mixture is shaped into a shaped mold for casting and curing at ambient temperature.

18. A method according to claim 15, 16 or 17 wherein the lightweight material is selected from the group consisting of one or more lightweight shaped polymeric products, one or more foamed products, foamed concrete, foamed polystyrene, and mixtures thereof.

19. A method of producing a rubber composite as defined in any one of claims 15 to 18 wherein step a) to c) comprise:

a) dry mixing rubber in an amount as defined in claim 2, an aggregate material in an amount as defined in claim 3, a lightweight material in an amount as defined in claim 6 and optionally a filler in an amount as defined in claim 4 in a pugmill/blender/mixer;

b) adding water to the dry mixture and mixing so as to form a homogeneous mixture; and

c) adding a bituminous material in an amount as defined in claim 5 to the damp homogeneous mixture and mixing to form a flowable rubber composite mixture.

20. The method of claim 19 wherein step b) comprises adding water in any one of the amounts selected from up to about 5wt% water, or up to 4.5wt% water, up to 4.0wt% water, up to 3.5wt% water, up to 3.0wt% water, up to 2.5wt% water, up to 2.0wt% water, up to 1.5wt% water, up to 1.0wt% water, up to 0.5wt% water, and up to 0.25wt% water, from 0.1wt% up to about 5wt% water, or from 0.1wt% up to 4.5wt% water, from 0.1wt% up to 4.0wt% water, from 0.1wt% up to 3.5wt% water, from 0.1wt% up to 3.0wt% water, from 0.1wt% up to 2.5wt% water, from 0.1wt% up to 2.0wt% water, from 0.1wt% up to 1.5wt% water, from 0.1wt% up to 1.0wt% water, from 0.1wt% up to 0.5wt% water, from 0.1wt% up to 0.25wt% water, from 0.2wt% up to about 5wt% water, or from 0.2wt% up to 4.5wt% water, from 0.2wt% up to 4.0wt% water, from 0.2wt% up to 3.5wt% water, from 0.2wt% up to 3.0wt% water, from 0.2wt% up to 2.5wt% water, from 0.2wt% up to 2.0wt% water, from 0.2wt% up to 1.5wt% water, from 0.2wt% up to 1.0wt% water, from 0.2wt% up to 0.5wt% water, and from 0.2wt% up to 0.25wt% water to the dry mixture and mixing so as to form a homogeneous mixture.

21. The method of any one of claims 15 to 20 wherein the lightweight material is as defined in any one of claims 9, 10 or 11.

22. The method of any one of claims 15 to 20 wherein the bituminous material is as defined in claim 13.

23. A method of spraying or pumping a rubber composite material onto a substrate comprising the steps of:

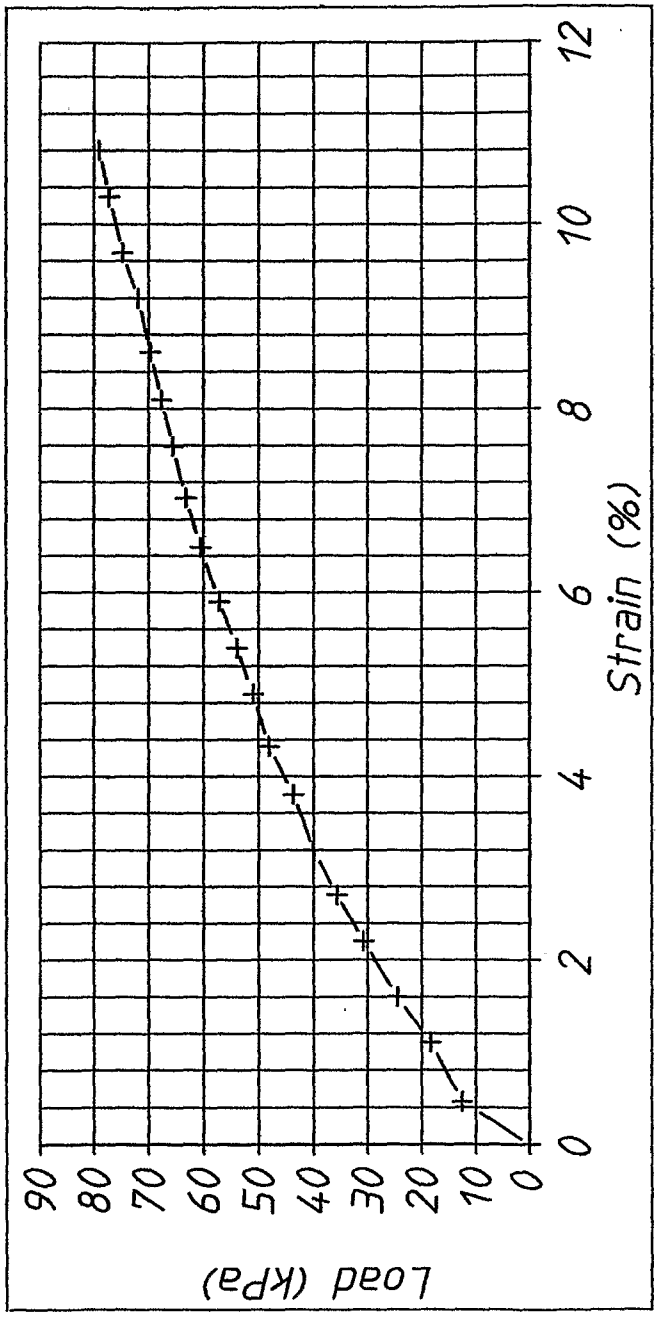
a) inserting a sprayable or pumpable rubber composite of any one of claims 1 to 13 in a pumping apparatus; and

b) spraying or pumping the rubber composite onto the substrate.

24. A rubber composite produced by the method according to any one of claims 15 to 22.

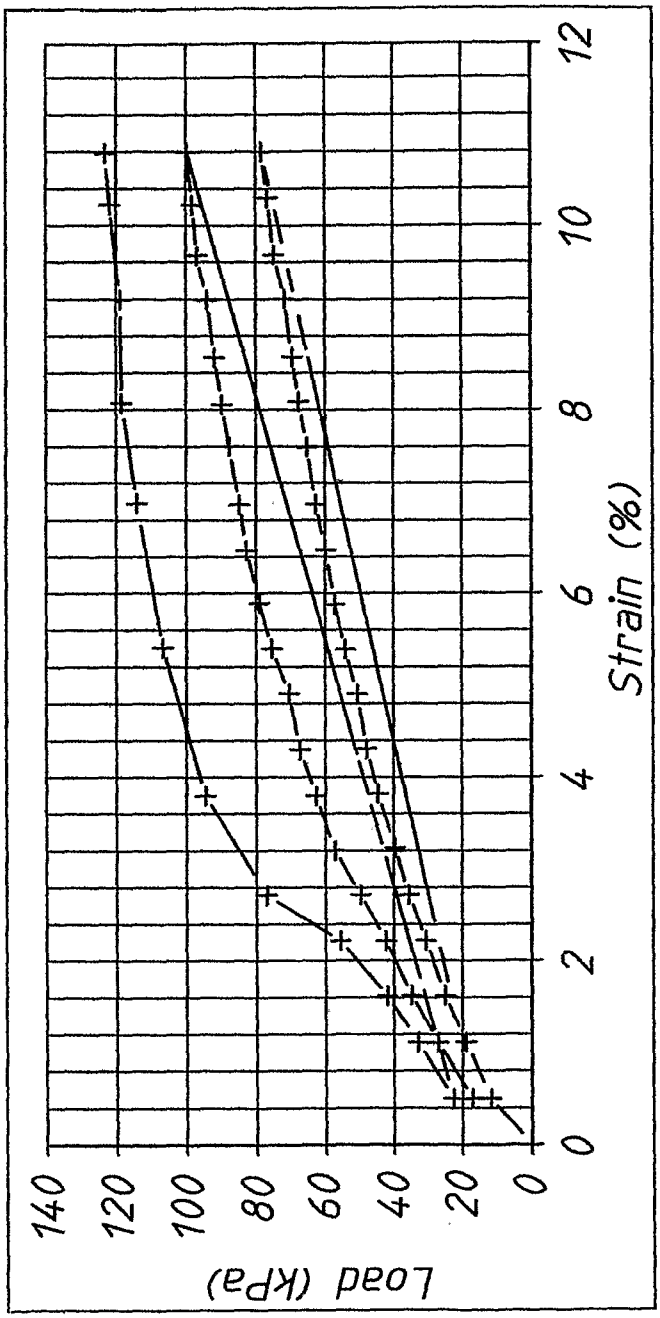
25. A rubber composite having a saturated hydraulic conductivity selected from any one of the ranges: about 500 to about 6000mm/hour, about 600 to about 5900mm/hour, about 700 to about 5800mm/hour, about 800 to about 5700mm/hour, about 900 to about 5600mm/hour, about 1000 to about 5500mm/hour, about 1200 to about 5400mm/hour,

about 1400 to about 5300mm/hour, about 1600 to about 5200mm/hour, about 1800 to about 5100mm/hour, about 2000 to about 5000mm/hour, about 2200 to about 5000mm/hour, about 2200 to about 5000mm/hour, about 2400 to about 5000mm/hour, about 2600 to about 5000mm/hour, about 2800 to about 5000mm/hour, about 3000 to about 4900mm/hour, about 3200 to about 4900mm/hour, about 3400 to about 4900mm/hour, about 3600 to about 4900mm/hour, and about 2500 to about 4800mm/hour produced by the method according to any one of claims 15 to 22.



Wet Density (t/m³)	0.92	Sample supplied by the client
Remarks: The specimen was tested as received.		

FIG. 1



Wet Density (t/m^3)	0.92	Sample supplied by the client
Remarks: The specimen was tested as received. Three load cycles were performed on the one specimen.		

FIG.2

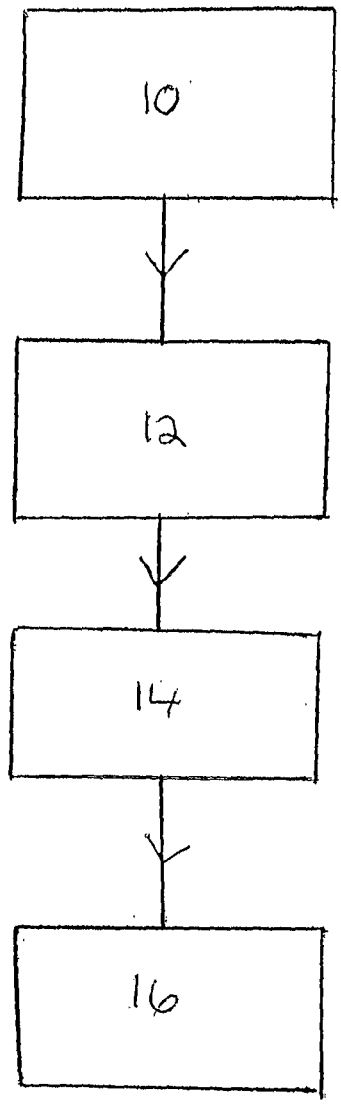


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2006/001973

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

C04B 24/36 (2006.01) ***C04B 24/24*** (2006.01) ***C08L 95/00*** (2006.01)
C04B 16/00 (2006.01) ***C04B 18/00*** (2006.01)

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)

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPIDS, JAPIO, USPTO, ESPACENET: bitumen, bituminous, asphalt, rubber, elastomer, polymer?, polystyrene, foam?, c04b, hydraulic conductivity

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5460649 A (STRASSMAN) 24 October 1995 See col 2 line 56-64, col 7 line 2-8, examples	1-3, 5, 6, 8, 9, 12, 14-21, 24, 25
X	DE 19738443 A1 (E. SCHWENK DÄMMTECHNIK GMBH & CO KG) 4 March 1999 See whole document	1, 3, 5, 6, 9, 10, 12, 13, 22, 24

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
31 January 2007

Date of mailing of the international search report
12 FEB 2007

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2006/001973

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 2826960 A1 (STRABAG BAU-AG) 3 January 1980 See examples	1, 3-6, 12, 24, 25
X	Patents Abstracts of Japan, JP 05-032446 (NICHIREKI CHEM IND CO LTD) 9 February 1993 (& JP 05-032446) (machine translation) See abstract, [0011], [0014], [0020], [0022]-[0024], [0028]-[0029], examples	1, 3-6, 14-17, 20, 21, 24
X	Derwent Abstract Accession no: 38776 D/22, Class A93L02, J56036-548 (KANEBO NSC KK) 9 April 1981 See abstract	1-6, 8, 9, 24
X	Derwent Abstract Accession no: 51723B/28, Class A93L02(A18), J54069-136 (HONSHU SHIKOKU RENR) 2 June 1979 See abstract	1-6, 9, 14, 24
X	US 5871034 A (SUMNER) 16 February 1999 See col 3 line 14-15, col 3 line 34-38, line 51-63, col 10 line 1-27, line 40-42, line 64-col 11 line 4	1-6, 15-17, 19, 22-24

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU2006/001973

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	5460649						
DE	19738443						
DE	2826960	AT	329179	BE	877107	LU	81398
		NL	7903920				
JP	5032446						
JP	56036548						
JP	54069136						
US	5871034	AU	33751/95	CA	2198881	CN	1163658
		EP	0784769	NO	970887	US	6092557
		US	6155305	US	6182705	WO	9607846

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX