CLAIMS

1. A railway track foundation, comprising:

a track bed which defines a track located on a track plane;

a mass of particulate material forming a layer located immediately beneath the track ~~plane~~bed, the particulate material comprising aggregate, soil, ballast, and/or sub-ballast; and

at least one geogrid located in ~~and/or below~~ the particulate layer, where the geogrid is in the form of an integral, molecularly oriented, plastics mesh structure,

where the at least one geogrid is located in a geogrid plane substantially parallel to the track plane where the average distance between the track plane and the geogrid plane, measured perpendicular to both planes, and denoted herein as Dr, is greater than 0.65 metres, and

where the railway track foundation has ~~having~~ a Rayleigh wave velocity (Vr) therein of at least 55 ms^{-1}.

~~2. The railway track foundation as claimed in claim 1, where the particulate layer is located immediately beneath the track bed.~~

~~3~~2. The railway track foundation as claimed in claim 1 ~~or 2~~, where the particulate layer has an average thickness less than Dr.

~~4~~3. The railway track foundation as claimed in any preceding claim in which Dr is greater than or equal to 0.7 metres.

~~5~~4. The railway track foundation as claimed in any preceding claim in which Dr is less than or equal to 5 metres.

~~6~~5. The railway track foundation as claimed in any preceding claim in which Dr is from 0.65 to 5 metres.

~~7~~6. The railway track foundation as claimed in any preceding claim where the particulate layer is additionally stabilized by at least one other mechanically stabilized layer and/or chemically stabilized layer.

~~8~~7. The railway track foundation as claimed in any preceding claim, where the geogrid is in the form of an integral, molecularly oriented, mesh, which comprises polymers which are substantially molecularly oriented in at least one direction.

~~9~~8. The railway track foundation as claimed in any preceding claim, where the geogrid comprises polymers and the polymers of the geogrid are molecularly oriented in at least two substantially perpendicular directions.

~~10~~9. The railway track foundation as claimed in any preceding claim, where the geogrid comprises interconnecting mesh defining elements including elongate tensile elements.

~~11~~10. The railway track foundation as claimed in any preceding claim, where the geogrid comprises transverse bars interconnected by substantially straight oriented strands, at least some of the strands extending from one bar to the next at a substantial angle to the direction at right angles to the bars and alternate such angled strands across the width of the geogrid being angled to said direction by equal and opposite angles.

~~12. The railway track foundation as claimed in any preceding claim, where the geogrid is in the form of an integral, molecularly oriented, plastics mesh structure.~~

~~13~~11. The railway track foundation as claimed in any preceding claim, where the geogrid has a thickness of from 0.1 to 5 mm.

~~14~~12. The railway track foundation as claimed in any preceding claim, where the geogrid comprises molecularly oriented polymers, and the molecularly oriented polymers that comprise the polymer geogrid are oriented by the polymer geogrid having been stretched in at least one direction at stretch ratio of at least 2:1.

~~15~~13. The railway track foundation as claimed in any preceding claim, where the geogrid has a tensile strength of at least 10 kN /m.

~~16~~14. The railway track foundation as claimed in any preceding claim, where the geogrid has mesh defining elements that have a width of 2 to 100 mm, the mesh defining elements defining mesh apertures having a mean length and/or a mean width of from 5 to 400 mm.

~~17~~15. The railway track foundation as claimed in any preceding claim having a Rayleigh wave velocity (Vr) therein of ≥ 69 ms^{-1}.

~~18~~16. The railway track foundation as claimed in any preceding claim, which further comprises a railway track having rails, where the rails are comprised of steel and have a critical track velocity at least 140 ms^{-1}.

~~19~~17. The railway track foundation as claimed in any preceding claim, wherein the geogrid has one or more, preferably two or more, more preferably three or more, even more preferably four or more, most preferably five or more, for example all six, of any of the following properties selected from (i) to (vi):

i) Radial Secant stiffness at 0.5% strain of at least 100 kN / m,

ii) Radial Secant stiffness at 2% strain (in kN / m of at least 80 kN / m,

iii) Radial Secant stiffness Ratio (dimensionless) of at least 0.5,~~;~~

iv) Junction efficiency of at least 90%,~~;~~

v) Pitch (preferably hexagon pitch) of at least 30 mm,

vi) Product weight of at least 0.100 kg/m^2.

~~20~~18. A method for constructing a railway track foundation, optionally the railway track foundation as claimed in any preceding claim, the method comprising the steps of:

providing a track bed which defines a track located on a track plane;

providing a particulate layer lying immediately beneath the track ~~plane~~ bed, the particulate layer comprising an aggregate layer, a soil layer, a ballast layer, and/or a sub-ballast layer, with a geogrid located in ~~and/or adjacent to~~ the particulate layer, wherein the geogrid is in the form of an integral, molecularly oriented, plastics mesh structure,

where the geogrid is located in a geogrid plane substantially parallel to the track plane where the average distance between the track plane and geogrid plane, measured perpendicular to both, and denoted herein as Dr, is greater than 0.65 metres, and

where the railway track foundation has a Rayleigh wave velocity (Vr) therein of at least 55 ms^{-1}.

~~21~~19. A geogrid suitable for use in a railway track foundation as claimed in any of claims 1 to ~~19~~ 17 and/or in a method as claimed in claim ~~20~~18, in which the geogrid has one or more, preferably two or more, more preferably three or more, even more preferably four or more, most preferably five or more, for example all six, of any of the following properties selected from (i) to (vi):

i) Radial Secant stiffness at 0.5% strain of at least 100 kN / m,

ii) Radial Secant stiffness at 2% strain (in kN / m) of at least 80 kN / m,

iii) Radial Secant stiffness Ratio (dimensionless) of at least 0.5,

iv) Junction efficiency of at least 90%,~~;~~

v) Pitch (preferably hexagon pitch) of at least 30 mm,

vi) Product weight of at least 0.100 kg/m^2.

~~22~~20. A geogrid stabilized particulate layer suitable for use in a railway track foundation as claimed in any of claims 1 to ~~19~~ 17 and/or in a method as claimed in claim ~~20~~18, which is obtained and/or obtainable by use of a geogrid as claimed in claim ~~21~~19.

~~23~~21. Use of a geogrid, the geogrid in the form of an integral, molecularly oriented, plastics mesh structure, ~~and/or component thereof~~ to increase the speed of the Rayleigh wave ~~therein~~ (Vr) within a particulate layer comprising aggregate, soil, ballast, and/or sub-ballast ~~and/or increase the critical track velocity along rails of a track laid thereon (Vc)~~ above a maximum allowed train velocity denoted Vt, where Vt is at least 55 ms^{-1}, by embedding the geogrid within the particulate layer.

~~24~~22. A railway track foundation, comprising:

a track bed which defines a track located on a track plane;

a particulate layer lying beneath the track plane; and

a geogrid located in and/or adjacent to the particulate layer,

where the geogrid is located in a geogrid plane substantially parallel to the track plane such that the geogrid stabilizes the particulate layer such that the properties of the particulate layer satisfy Equation 4A;

$$55 \geq \left(\frac{A+B\upsilon}{1+\upsilon}\right)\sqrt{\frac{G_0}{\rho}} \qquad \text{Equation 4A}$$

where

A is a dimensionless constant, the value of A being from 0.8 to 1.0;

B is a dimensionless constant, the value of B being from 1.0 to 1.2;

υ denotes the Poisson ratio of the particulate layer, which is from 0.1 to 0.5;

G_0 is the small strain stiffness property of the particulate layer; and

ρ is density of the particulate layer.

~~25~~23. A method for constructing a railway track foundation, the method of construction comprising:

defining a track bed plane along which the track bed will be located;

providing a particulate layer beneath the track plane with a geogrid located in and/or adjacent to the particulate layer,

where the geogrid is located in a geogrid plane substantially parallel to the track plane such that the geogrid stabilizes the particulate layer such that the properties of the particulate layer satisfy Equation 4A;

$$55 \geq \left(\frac{A+Bv}{1+v}\right)\sqrt{\frac{G_0}{\rho}} \qquad \text{Equation 4A}$$

where

A is a dimensionless constant, the value of A being from 0.8 to 1.0;

B is a dimensionless constant, the value of B being from 1.0 to 1.2;

υ denotes the Poisson ratio of the particulate layer, which is from 0.1 to 0.5;

G_0 is the small strain stiffness property of the particulate layer; and

ρ is density of the particulate layer.

~~26~~24. Use of a geogrid in a method to construct a railway track foundation, comprising:

defining a track bed plane along which the track bed will be located;

defining a particulate layer lying beneath the track plane with a geogrid located in and/or adjacent to the particulate layer,

the geogrid being located in a geogrid plane substantially parallel to the track plane such plane being defined such that the geogrid is calculated to stabilize the particulate layer such that the properties of the particulate layer satisfy Equation 4A;

$$55 \geq \left(\frac{A+Bv}{1+v}\right)\sqrt{\frac{G_0}{\rho}} \qquad \text{Equation 4A}$$

where

A is a dimensionless constant, the value of A being from 0.8 to 1.0;

B is a dimensionless constant, the value of B being from 1.0 to 1.2;

υ denotes the Poisson ratio of the particulate layer which is from 0.1 to 0.5,

G_0 is the small strain stiffness property of the particulate layer; and

ρ is density of the particulate layer.

~~27~~25. The railway track foundation of claim ~~24~~22, the method of claim ~~25~~23, or the use of a geogrid in a method to construct a railway track foundation as claimed in claim ~~26~~24, wherein the average distance between the track plane and geogrid plane, measured perpendicular to both, and denoted herein as Dr, is greater than 0.65 metres.

~~28~~26. A particulate material stiffened and/or strengthened by the method of claim ~~20~~ 18 or ~~25~~23.

~~29~~27. A railway track foundation comprising a mass of particulate material strengthened by embedding therein a geogrid as claimed or described in any preceding claim.