533 Composite Materials

**Laminates**

1. Describe and define a timber laminate.

Timber laminates are products where a number of thin timber sheets (veneers) are glued together to increase the strength of the laminate over that of individual boards. It is common to glue alternate layers so that the grain of each layer is at right angles to the next. Any timber defects, or poor grain, in a layer is reinforced by the sheets on either side, thus strengthening the whole.

Common timber laminates include plywood and structural beams.

1. Explain the advantages of timber laminates for structural applications.

In structural applications the advantages of laminates over solid timber members is due to the fact that harvested timber has limited length, limited thickness, and limited strength. Deformities including knots, cranky grain, termite and beetle attack can also weaken timber. Lamination combines the strength of the natural timber and the strength of the glue used to construct the laminate.

**Asphalt**

1. Describe and define asphalt.

Asphalt is a composite engineering material used in the construction of road surfaces. It is made up of a liquid phase, tar, fine aggregate, and sand. It is usually placed hot!

Tar (bitumen) is a by-product of the petroleum industry and fine aggregate is mined from basalt or sandstone quarries.

The combination has often been referred to as TarMac – a historical term gleaned from Tar and a historical road construction method Macadam. The pavement was designed for heavier trafficked streets and composed of 2.5” stone laid in one or two courses of sandstone base coating.

1. Explain the advantages of asphalt as a surface layer.

Asphalt has an advantage over other roadbase materials in that it is reasonably strong, porous, tenacious, stable and to some degree flexible. It is best used as a top layer over solid, firm, rock-based road construction.

**Geotextiles**

1. Describe and define a geotextile.

A modern woven matt of strong, porous, flexible polymeric materials. Used in road construction between the base coat, and the top coat to provide strength and drainage for road surfaces.

1. Explain the advantages of geotextile in a structure.

For strength to hold the sub-surface together, porous to improve drainage of road surfaces, and wear resistant.

They contain roadbase fines (rock) that prevent the surface from being washed away. Early road base materials included clay, sand and aggregate, and these were regularly washed out of the roadway, creating dangerous surfaces.

**Concrete**

Define concrete.

Concrete is probably the most widely used material for structural and architectural applications worldwide. Having developed from pozzolana deposits in Europe, it too, is a composite. Its use for various forms of human endeavour has expanded massively since its discovery in Roman times.

The base for concrete is the material Portland Cement (more commonly cement) which is made in a rotary kiln from a mix of Lime, Silica (Sand), Alumina, and Iron Oxide. After high temperatures in the kiln, the reacted components are cooled, and ground to a fine powder - cement.

When mixed with sand aggregate and water in measured quantities, the powdered cement begins to react chemically with the alumino-ferro-silicates to form a number of hydrated crystals and amorphous gels. These components first stiffen the pour and over time (28 days) increase the cement hardness, decreasing porosity.

1. Explain the advantages of concrete as a structural component.

As a structural component, concrete has numerous advantages over other structural elements;

It is stable

It is strong and durable,

It is easily handled from supplier to the site.

It is relatively cheap, and widely available across the globe.

1. Describe methods of reinforcing Concrete.
   1. Reinforcing Bars or Mesh.

Concrete is very strong in compression, and about 1/10th of that in tension. Concrete structures, by their nature, produce areas of high stress that need to be supported. To enable both the tensile and the compressive stresses to be supported in a concrete structure steel rods, bars or mesh are cast into the concrete mix on the tensile side to take the applied stresses when cured. Steel, being good for resisting tensile stress compliments the concrete’s lower compressive stresses.

* 1. Post Tensioned Concrete

In this form of reinforcement the structural section is cast in a mould. A number of tubes are cast into the mould (on the tensile stress side). When cured, steel cables are drawn through the tubes, and anchored at each end. They are then attached to hydraulic jacks that tension the cables thus bringing the structure into compression.

In operation the comprehensive stress in the structure has to be overcome by active forces before the system can fail.

* 1. Pre-Tensioned Concrete

In this form of reinforcement the structural section is cast in a mould. Reinforcing cables are placed in the wet cast concrete from end to end. The cables are tensioned (loaded) before the concrete is poured. When cured, the strain on the cables is released drawing the concrete into compression.

In operation the comprehensive stress in the structure has to be overcome by external active forces before the system can fail.

**Concrete Testing**

1. Slump Test

Concrete as a fluid needs to be controlled in a number of ways, including its ability to flow into cavities within the mould. In the slump test samples of a concrete mix are taken during pouring at the job site. These are then placed in a simple jig that locates the sample, a bit like a cone shape. This jig is lifted to allow the mix to flow. If the mix has too much moisture it will spill out from under the jig, if not enough the mix will stand firm.

1. Compressive test

Samples taken from a given mix are cast into a standard cylindrical mould, allowed to set and cure under set conditions. After curing the sample is measured and set in a Compression testing machine (tensometer). Compressive forces are applied until the sample fails. Results are documented for the project.

JWG