

Lightweight aggregates manufactured from Pulverised Fuel ash

Introduction

Pulverised Fuel Ash (PFA) can be used to manufacture a lightweight, yet strong, aggregate suitable for a variety of uses. This aggregate is called 'sintered pulverised fuel ash lightweight aggregate', yet more commonly known as Lytag.

Lightweight aggregates are made by pelletising the PFA. The pellets are formed by adding a controlled amount of water in specially designed dish pelletising pans. These are then heated on a sinter strand where the temperature is between 1000 and 1250C. Waste fuel oil is used to provide the heat energy, with the assistance of the small amount of unburned carbon within the PFA, which helps to fuse the particles together. The water is driven off resulting in a hard, honeycombed structure of inter-connecting voids within the aggregate. The aggregate formed varies in size from 14mm down to fines. This is then graded into a variety of sizes.



Physical Properties of Lightweight Aggregate

- **Densities** - The dry bulk density of lightweight PFA coarse aggregates is typically in the range of 750 to 850kg/m³. Particle densities range from 1,350 to 1,650kg/m³. Normal weight aggregates have typical bulk densities of 1,650kg/m³ and particle densities of 2,700kg/m³. Therefore, the use of lightweight aggregate can reduce the dead weight by up to 50% with no loss in strength.
- **Fire Resistance** - lightweight PFA aggregate has excellent fire resistant properties because the aggregate has been produced by a refractory process. In addition, the cellular structure of the aggregate particles relieves any pressures from expanding gases. The result is a material that is highly fire resistant.
- **Freeze Thaw** - The high void ratio, typically 40%, gives lightweight PFA aggregate excellent freeze thaw properties.
- **Shape** - lightweight PFA aggregate generally has a spherical shape resulting from the pelletising technique used. This leads to minimal settlement after placing.

Applications

Lightweight PFA aggregates have a wide number of applications:

- **Structural Lightweight Concrete** - lightweight PFA aggregates have been used in lightweight concretes since the early 1960's. The reductions in concrete density have a significant effect on the dead load of the structure. Consequently foundation sizes can be reduced, more floors can be constructed, more slender beams can be used, etc. Lightweight PFA aggregates can be used in precast units with the associated reduction in transport costs and environmental impact, less crange, etc.
 - **Density** - typical concrete densities range from 1,550kg/m³ to 2,000kg/m³.
 - **Durability** - water absorbed into the cellular structure of the aggregate aids the curing process resulting in more complete cement hydration.
 - **Thermal expansion** - the coefficient of thermal expansion is typically two thirds that of normal gravel concretes.



- **Strength range** - characteristic strengths between 20N/mm² and 80N/mm² are possible - similar to normal density concrete.
- **Fire resistance** - because of the reduced coefficient of thermal expansion and insulating properties fire resistance is superior to most normal concretes.
- **Refurbishment** - because of the reduced concrete densities, lightweight concrete is an ideal material for refurbishing structures. It provides strength without adding excessive dead loads.

● **Floor and roof screeds** - lightweight PFA aggregates have been widely used throughout the UK in floor and roof screeds giving lower densities, improved thermal insulation and can use less cement than traditional screeds.

◆ **Density** - lightweight screeds have a typical density of $1,100\text{kg/m}^3$ - approximately half that of traditional sand/cement screeds.

◆ **Shrinkage** - 'no fines' lightweight aggregate screeds have relatively low shrinkage characteristics allowing large bays to be laid in one operation.

◆ **Drying out** - 'no fines' lightweight aggregate screeds allow air to circulate between the particles thereby allowing the screed to dry out in approximately two thirds of the time of traditional screeds.

◆ **Thermal insulation** - the thermal conductivity of lightweight screeds is typically 4 times better than traditional screeds. Consequently, extra insulation may be saved.

◆ **Sound Insulation** - a 50mm depth of lightweight aggregate screed will reduce airborne sound by between 3 to 6dB.



● **Drainage media** - The particles size and shape of lightweight PFA aggregates give them excellent hydraulic conductivity properties. It can be shown that up to six times more water will pass through lightweight PFA aggregates than standard gravel aggregates, reducing the risk of silt blockages in trench systems. Finely graded lightweight aggregate can be used allowing grass to grow and 'knit' over the trench in a few days.

● **Filter media** - lightweight PFA aggregate is an excellent medium for biological filtration. The particle shape and structure are ideal for where bacterial films have to anchor and develop. The aggregates are resistant to acids and therefore the filter media has a long life.

● **Arrestor beds** - lightweight aggregate can be used in arrestor beds, which are used to stop runaway vehicles in a controlled manner. Damage to vehicles is minimised in comparison to that caused by a crash. Lightweight PFA aggregate does not compact over time so the vehicle sinks into the bed allowing drag forces to stop it safely.

● **Bulk Fill** - lightweight aggregate can be used as a bulk fill material either bonded with cement or unbonded.

Densities are typically very low at around 800 to 900 kg/m^3 . This reduces the dead load, lateral pressure and other loads on a structure. Due to the spherical shape of the aggregate minimal compaction is required.



● **Sports surfaces and play areas** - special grades of lightweight PFA aggregates are used for sporting and play area applications. Specialist contractors build such systems, which are sufficiently firm to allow people to run on yet soft enough to minimise injury.

● **Horticultural uses** - special grades of lightweight PFA aggregates can be used as a growing medium for plants. The moisture retention, up to 15%, of lightweight aggregates provides a

controlled water release to the plants. In addition, seedlings are not bound into the growing medium but grow between the aggregate particles. This allows for easier transplanting with minimal root damage.

● **Refractory uses** - they can be used in temperatures of up to 1050C , such as in flue linings, ladle insulation and specialist coatings.

● **Other uses** - lightweight aggregates are also used for tunnel linings, piggery floors, pipe bedding, etc.