ARMCON

Coarse Aggregate

– An Overview

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Coarse Aggregate, an Overview:

Top Tips

- Use grading charts if unsure about the aggregate
- Use all available data to assess materials
- Cheaper initial cost may not always mean cheaper concrete
- Pick the aggregate with the properties that will ensure the final product fits the specification.

Overview

In the context of concrete, ‘Coarse Aggregate’ is an aggregate larger or equal to 4mm wide, this is ‘generally’ the standard size used in concrete (not precast concrete).

Coarse aggregate is available in graded size and single graded size.

As an example a graded size 4mm wide aggregate mixed with 20mm wide aggregate and everything in between.

A single graded size is for example 10mm wide aggregate mixed with 20mm wide aggregate but nothing in between.

An all-in aggregate contains fine material, and an example could be 0/20mm meaning it contains anything from 0mm to 20mm. (you could class this under graded size, but its worth mentioning)

Therefore grading the material will produce a graded size (e.g. 4/20mm) or a single sized (10/20mm) notation as well as give details on the amount of oversized and undersized material in the stockpile.

Besides aggregate size, consider the shape, surface finish, hardness and material when selecting a coarse material for producing concrete.

Size

It is generally accepted that the larger the aggregate the stronger the concrete. This benefit is then met with the negative that it is harder to get a surface finish with larger aggregate.

When precasting a 40mm size or above aggregate should be avoided, instead use a single size 4/10mm. Using the single sized aggregate will allow for a good surface finish on the concrete product, however it also means that cement content of the mix will need increasing (when compared with using 20mm coarse aggregate) to allow for a good de-mould time and final product strength.

Shape

The shape of aggregates in concrete directly impacts the density of the concrete. The better the aggregate packs together the denser the concrete. This directly affects the strength of the concrete.
A particle is measured in three dimensions to give it a classification of, spherical, cubical, flaky, elongated or flaky & elongated.

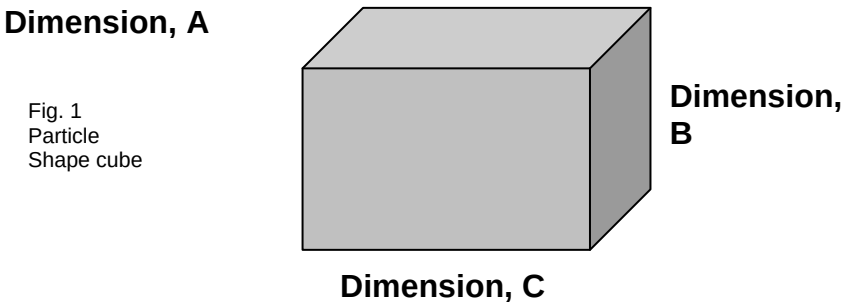

Fig. 1
Particle
Shape cube

The shape of the particles in the coarse aggregate is critical to the durability and strength of the concrete as a good aggregate interlock (or aggregates that fit well together well) will give good compaction and a denser concrete.

Particles that are too flaky elongated or both are less likely to give a good aggregate interlock and may produce weaker concretes than those made with cubical or spherical particles.

Crushed/broken and rounded particles (Cubical and Spherical) are more likely to produce stronger concretes, but there are also differences between these two particles that will give slightly different properties to the concrete they are contained within.

Rounded Particles have:

- Lower surface area
- Better workability
- Easier to compact
- Better surface finish

Crushed or Broken Particles:

- Harder to compact
- More water needed to ensure workability
- May require more cement
- Better aggregate interlock

It should be noted that no particular shape is best and that shape is a factor to bring into consideration when deciding about quality of finish and density.

Surface finish

Identifying the surface finish of coarse aggregate is something that is easily done and for this only crushed/broken or round particles are considered. Surface finish of coarse aggregates will affect interlock, specifically particles with smoother surfaces will struggle creating interlock unlike a rough or broken particle.

To aid with identification the following descriptions are given:

Totally crushed or broken particle – particles with 90% or more of its surface crushed or broken with sharp edges.

Crushed or broken particle – when 50% or more of a particles surface is crushed or broken with sharp edges.

Rounded particle – particles with 50% or less of the surface crushed or broken with sharp edges

Totally rounded particle – particles with more than 90% rounded and worn surfaces.

Hardness

When testing course aggregates the particle resistance to fragmentation is what is examined. The test used to determine this resistance to fragmentation is called the Los Angeles test and the test will pulverise the aggregate particles so that an aggregate is then designated a Los Angeles coefficient value.
The scale of the coefficient works in a descending order, with large numbers being materials with a low resistance to fragmentation and small numbers obviously being materials with a high resistance.

As a guide typically limestone will have a value around 20. So anything with a higher number will have a lower hardness and anything with a lower number will be more resistant.

Type (Quality)

The type of aggregate and its associated quality will directly affect the final strength, durability and working life of the concrete it makes.

Coarse aggregate can be split into two main types, virgin material and recycled material. Virgin material is new coarse particles from various sources (quarries, marine

dredging or mining) that have been graded and passed as suitable by British Standards for use in concrete. However there can still be problem with virgin materials that concrete producers should be aware, for example marine dredged aggregates will contain materials like shells and the amount of shells in these aggregates should be known. In marine dredged aggregate shells will not react with other elements of the concrete but they will create voids that are then harmful to the durability and strength of the concrete and for this reason the shell content of marine dredged aggregate should be no more than 10%.

It is also now possible to use recycled materials in concrete but with restrictions on the type that is permissible. The two definitions used in concrete are:

- RA – recycled aggregate for use in concrete, principally comprising crushed masonry/
- RCA – recycled concrete aggregate for use in concrete, principally comprising crushed concrete.

The two definitions are from the WRAP protocol and have definitions in the British Standard BS 8500, ‘Specifying concrete’.

The overall quality of an aggregate can be gained by taking into account all the other properties previously discussed.

By using the correct aggregates you can control how easy your concrete is to handle, the quality of your concrete and reduce your cost.