Subject- Building Material

Aggregate

Lecture - 1

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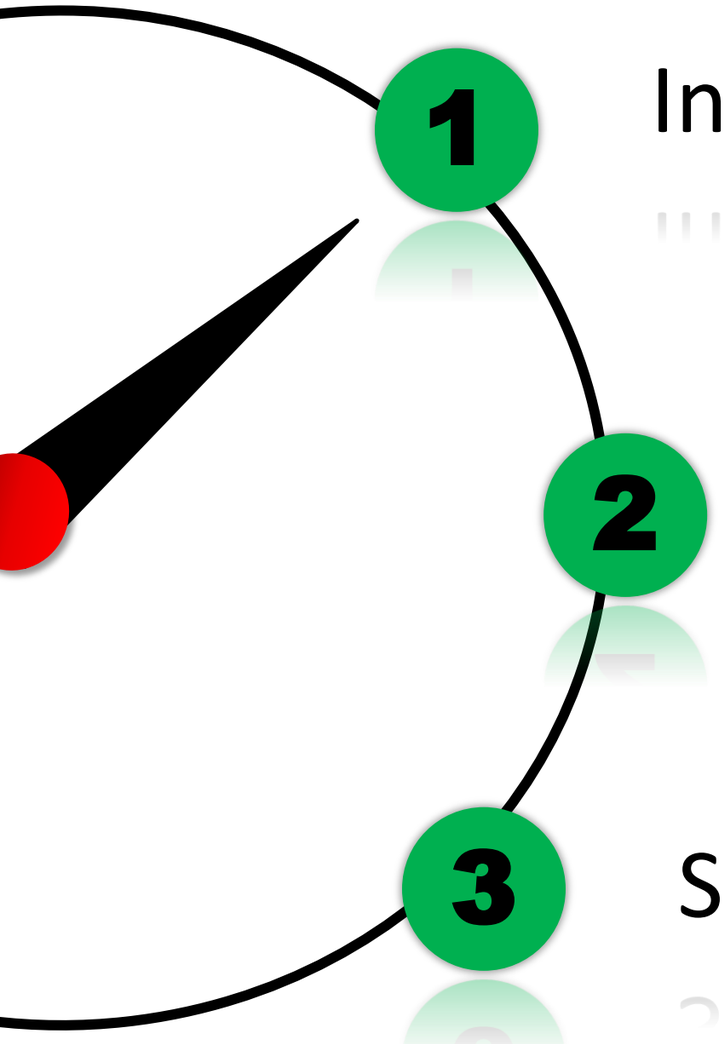
Content



1 Introduction of Aggregate

2 Types of Aggregate

3 Summary

Introduction

- Aggregates are the materials basically used as ***filler*** with ***binding material*** in the production of ***mortar*** and ***concrete***. They are derived from ***igneous, sedimentary*** and ***metamorphic rocks*** or ***manufactured*** from ***blast furnace slag***, etc.
- Aggregates form the body of the concrete, ***reduce the shrinkage*** and effect economy.
- Aggregates occupy ***70-80%*** of the ***volume*** of ***concrete*** therefore it affect the various property of concrete.

Introduction

To increase the bulk density of concrete aggregates are used in two markedly different sizes—the ***bigger ones known to be coarse aggregate (grit)*** and the ***smaller ones fine aggregate (sand)***. ***Coarse aggregate*** form the ***main matrix of concrete*** and the ***fine aggregate*** form the ***filler matrix between the coarse aggregate***.

Introduction

Cement is the only factory made standard component in concrete. Other ingredients, namely, water and aggregates are natural material and can vary to any extent in many of their properties. So in-depth study is required.

Therefore ***aggregates*** significantly important to obtain ***right type and quality of aggregates*** at site. They should be clean, hard, strong, durable and graded in size to achieve utmost economy from the paste.

Introduction

To know more about the concrete, it is very essential that one should know more about the aggregates which constitute major volume in concrete.

Classification of Aggregate

On the basis of Geological Origin

Type of Aggregate

Natural

Artificial

Broken Bricks
Air Cooled Slag
Sintered Fly Ash
Bloated Clay

Igneous Rock

These are formed by cooling of the molten magma or lava at the surface of the crest (trap and basalt)or deep beneath the crest

Sedimentary Rock

These are formed below the sea bed and subsequently lifted up

Metamorphic Rock

These are originally either igneous or sedimentary rocks which are subsequently metamorphosed due to extreme heat and pressure

Aggregate from Igneous rocks

Normally these aggregates are ***hard, dense*** and tough structure entirely crystalline or wholly glassy or in combination in between, depending upon the ***rate at which they were cooled during formation***, Acidic or basic depending upon the % of silica content. These are chemically active and react with the alkalis in cement. As the igneous rock is one of the widely occurring type of rocks on the face of the earth, bulk of the concrete aggregates, that are derived, are of igneous origin.

Aggregate from sedimentary rocks

Igneous and metamorphic rock are subjected to ***weathering agencies*** such as sun, wind and rain. These WA decompose *fragmentize*, *transport* and ***deposit*** the *particle of rock deep beneath the ocean bed* where they are ***cementing*** together by some of the ***cementing material*** (***Carbonaceous, siliceous or argillaceous in nature***). Same time it is subjected to static pressure of water and become compact sedimentary layer.

Aggregate from sedimentary rocks

The sedimentary rocks subsequently lifted up and became a ***continent***. The sedimentary rock with the stratified structure are quarried and concrete aggregates are derived from it. Sedimentary rocks vary from soft to hard, porous to dense and light to heavy. The degree of ***consolidation***, the type of cementation, the thickness of layers and contamination, are all important factors in determining the suitability of sedimentary rock for concrete aggregates.

Aggregate from Metamorphic rocks

Both igneous and sedimentary rock are subjected to high temperature and pressure which causes metamorphism which changes the structure and texture of rocks. Metamorphic rock show foliated structure. The thickness of this foliation may very from few centimeters to many meters. If thickness of this foliation is less, then it is not desirable characteristics for good aggregate. However, many metamorphic rock quartzite and gneiss have been used for production of good aggregates .

Classification of Aggregate

On the basis of size

Aggregate

- Fine Aggregate
  - Particle sizes less than 4.75mm
- Coarse Aggregate
  - Particle sizes greater than 4.75mm
- All in Aggregate
- Graded Aggregate

Naturally available aggregates of different fractions of fine and coarse sizes are known as all-in-aggregate. The deficiency of any particular fraction can be corrected for use in the mix but they are not recommended for quality concrete.

Aggregate most of which passes through a particular size of sieve are known as graded aggregate. For example, a graded aggregate of nominal size 20 mm means an aggregate most of which passes IS sieve 20 mm.

Classification of Aggregate

e.g. of heavy weight aggregate

1. **Barites**- Density is 3500 kg/m^3 which is 45% greater than the normal weight concrete
2. **Magnetite**- Density is 3900 kg/m^3 which is 60% greater than the normal weight concrete.
3. **Iron or lead Shot**- Density 5900 kg/m^3 - 8900 kg/m^3 respectively. Very heavy concrete can be achieved.

Classification of Aggregate

IS Sieve Designation	Percentage passing by weight			
	Grading (Zone I)	Grading (Zone II)	Grading (Zone III)	Grading (Zone IV)
10mm	100	100	100	100
4.75mm	90-100	90-100	90-100	95-100
2.36mm	60-95	75-100	85-100	95-100
1.18mm	30-70	55-90	75-100	90-100
600 micron	15-34	35-59	60-79	80-100
300 micron	5-20	8-30	12-40	15-50
150 micron	0-10	0-10	0-10	0-15

IS 383:1970 specification for coarse and fine aggregates from natural sources for concrete

Classification of Aggregate

On the Bases of Shape

Rounded Aggregates

These are generally obtained from river or sea shore and produce minimum voids (about 32 per cent) in the concrete. They have minimum ratio of surface area to the volume, and the cement paste required is minimum. Poor interlocking bond makes it unsuitable for high strength concrete and pavements.

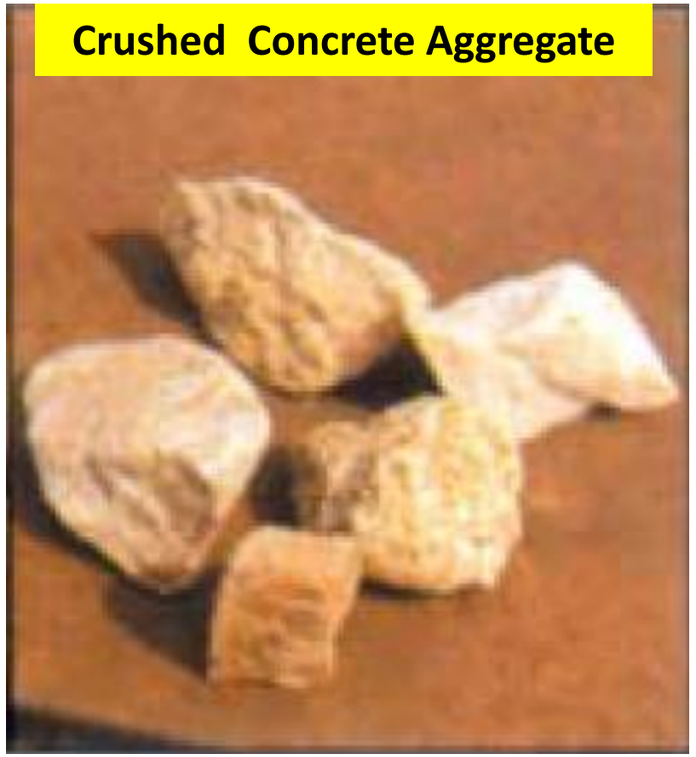
Classification of Aggregate

Angular Aggregate

They have sharp, angular and rough particles having maximum voids (about 40 per cent). These aggregates are obtained by crushing the rock. Angular aggregate provide very good bond than the Irregular and round aggregates, are most suitable for high strength concrete and pavements; the requirement of cement paste is relatively more.

Angular Concrete Aggregate

Crushed Concrete Aggregate



Irregular Aggregate

They have voids about 36 per cent and require more cement paste as compared to rounded aggregate. Because of irregularity in shape they develop good bond and are suitable for making ordinary concrete.

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Classification of Aggregate

Flaky Aggregate

These are sometimes wrongly called as elongated aggregate. However, both of these influence the concrete properties adversely. The least lateral dimension of flaky aggregate (thickness) should be less than 0.6 times the mean dimension.

For example, the mean sieve size for an aggregate piece passing through 50 mm and retained on 40 mm sieve is $(50 + 40)/2 = 45.0$ mm. If the least lateral dimension is less than $0.6 \times 45 = 27.0$ mm, the aggregate is classified as flaky.

Elongated aggregate are those aggregate whose length is 1.8 times its mean dimension. Flaky aggregate generally orient in one plane with water and air voids underneath. They adversely affect durability and are restricted to maximum of 15 per cent.

Flaky Concrete Aggregate

Elongated Concrete Aggregate

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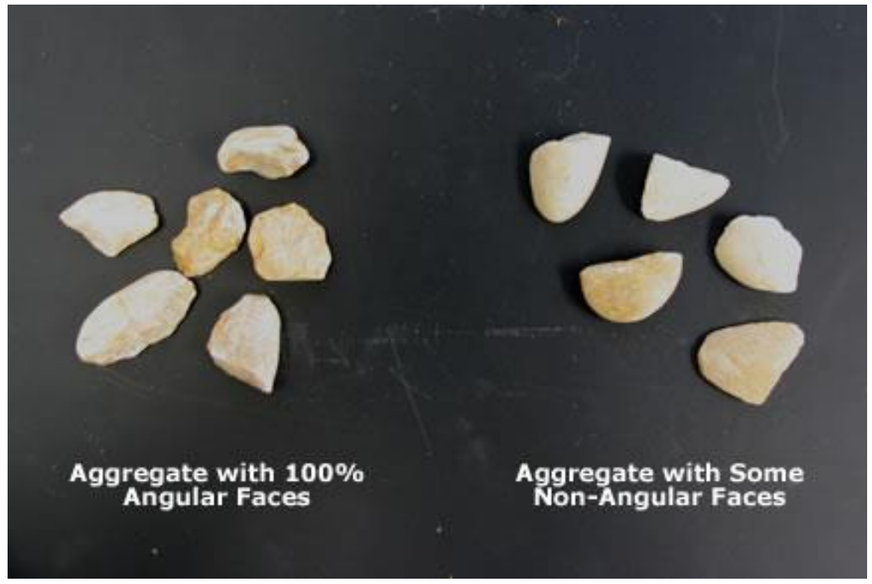
Shetty MS, Concrete Technology

Classification of Aggregate

https://www.dot.state.mn.us/materials/manuals/laboratory/1214.pdf

Classification of Aggregate



- *Very sharp and rough aggregate particles or flaky and elongated particles require more fine material to produce a workable concrete. Accordingly, the water requirement and, therefore, the cement content increases. Excellent concrete is made by using crushed stone, but the particles should be roughly cubical in shape*
- *The flakiness and elongated tests are describes in IS: 2386 (part I)*

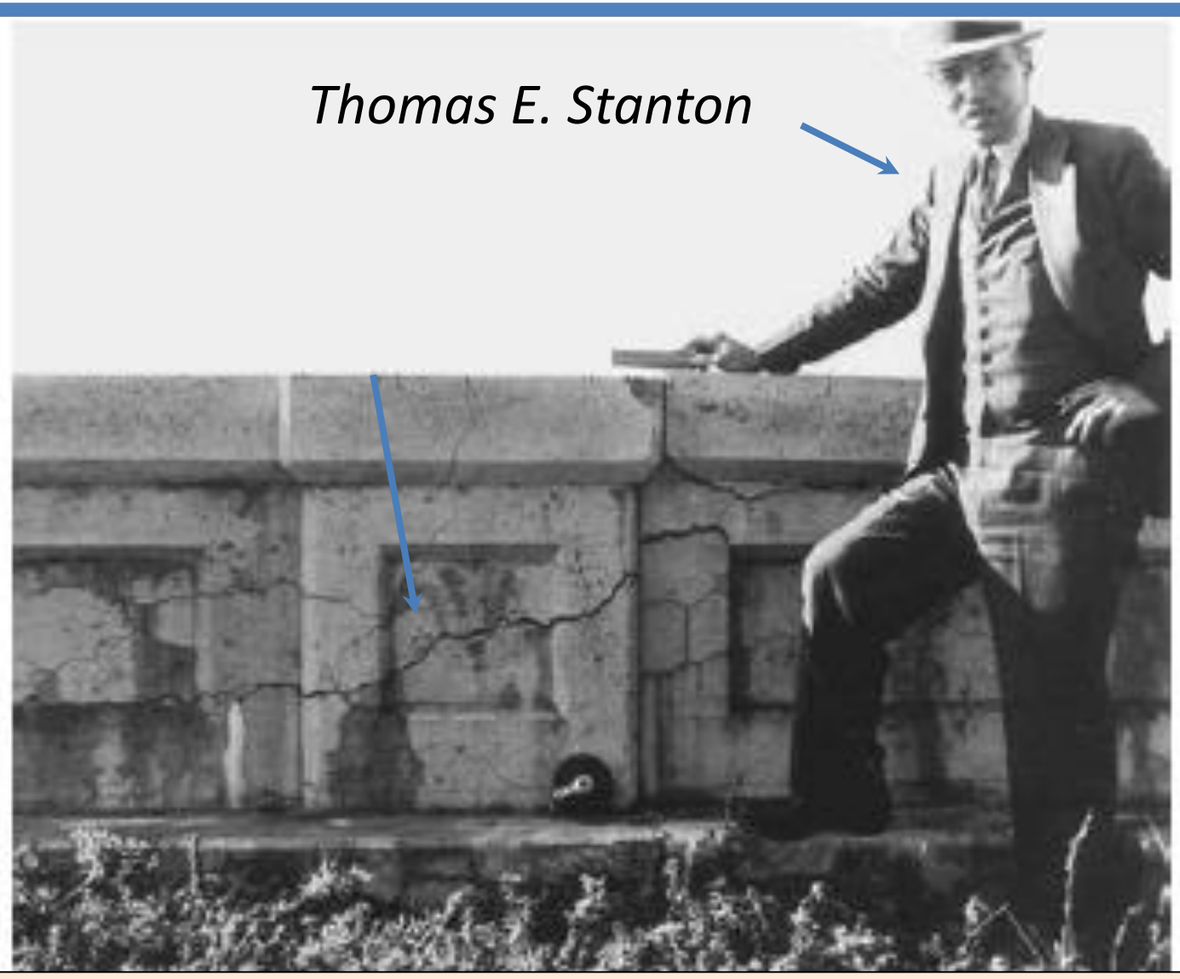
https://pavementinteractive.org/reference-desk/testing/aggregate-tests/coarse-aggregate-angularity/

Classification of Aggregate

Chemical reaction between alkalis in cement and mineral constituents in aggregate within hardened concrete; due to differential rate of volume change in different members of the concrete;

ACI 201.1R-08, Guide for Conducting a Visual Inspection of Concrete in Service

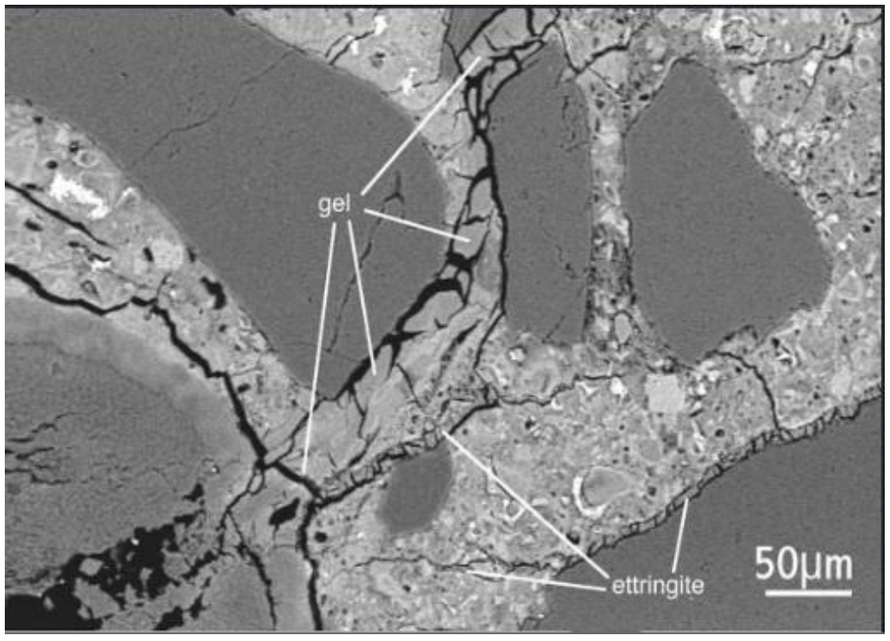
Classification of Aggregate



Thomas E. Stanton was the first to provide a comprehensive explanation for the damages that occurred in the California Highway system in the late ‘30s. He proposed that the deterioration was caused by the expansion of a gel generated by *the reactive silica from the aggregate and the alkalies from the cement*.

Mehta, pk., Concrete microstructure, properties, and Materials

Classification of Aggregate



https://www.understanding-cement.com/alkali-silica.html
https://en.wikipedia.org/wiki/Alkali%E2%80%93silica_reaction
https://www.mekaglobal.com/en/blog/case-study-alkali-silica-reaction-concrete-cancer

Summary

- ✓Introduction of Aggregate
- ✓Types of Aggregates

THANK YOU