

Particle size distribution in concrete technology practice

Make bones of your concrete
stronger!

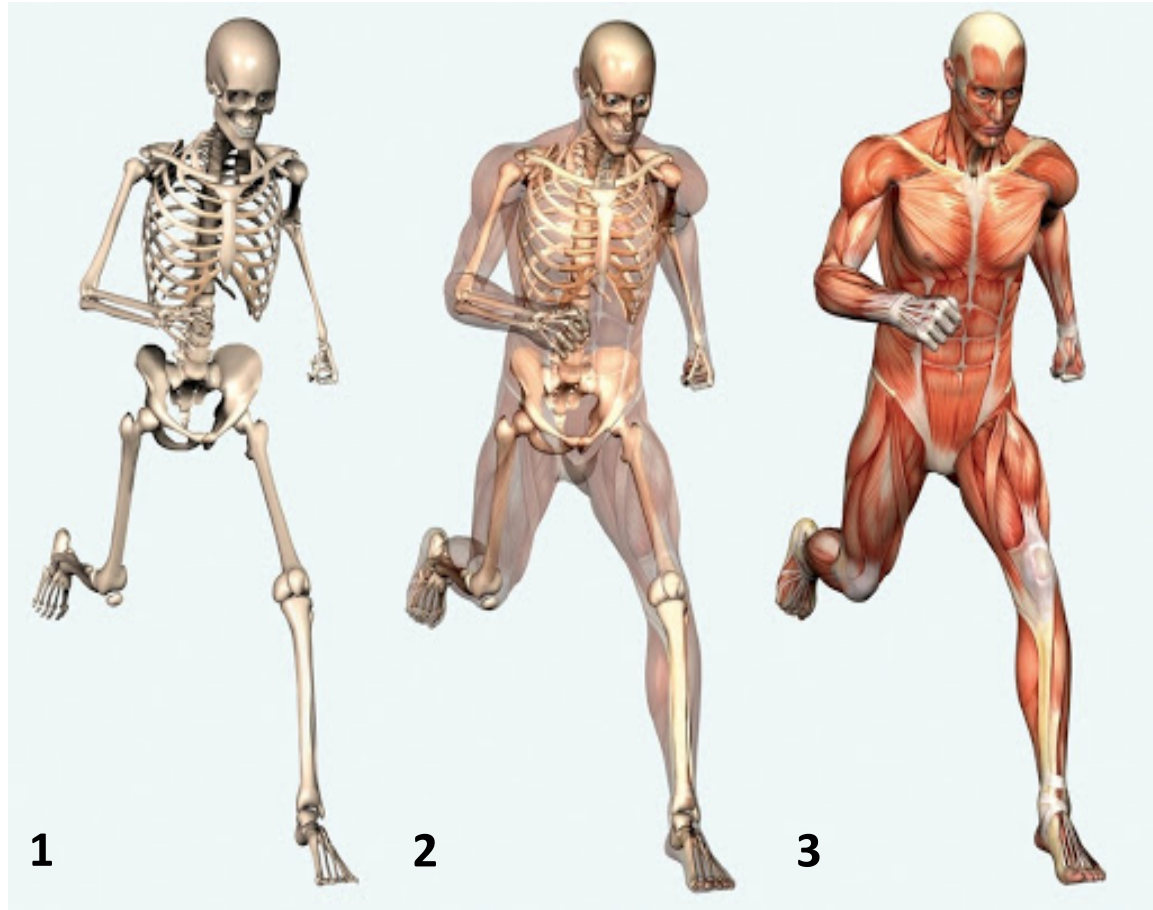
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PSD as a basic step of mix design optimization

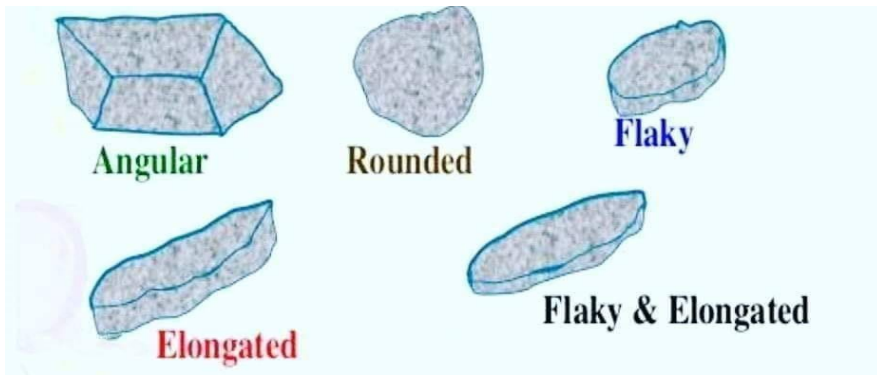
3 steps of good mix design:

- Bones (PSD)
- Meat (Binder & fillers)
- Vitamins (Admixtures)

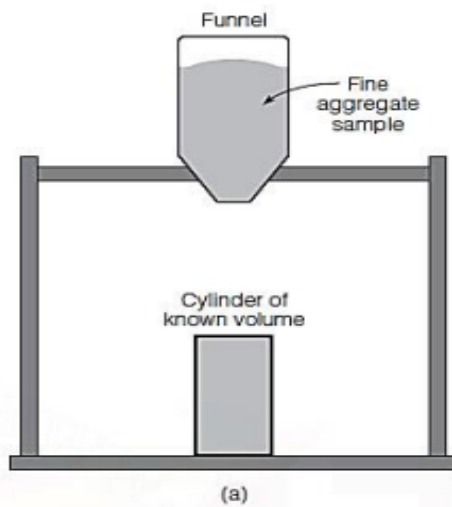
**With a broken leg
vitamins are
not effective!**



What matters for proper packing?



- Grading
- Surface shape
- Surface texture



**Total voids
of the aggregates**

What matters for PSD?

Surface shape (example)



- Same granite, Same quarry, Same RMC plant, Same mix design, but
- New crushing plant, F.I. of C.A. from 32% to 11%
- Less voids, more paste!

Total specific area concept

How far is it from regular engineering practice?



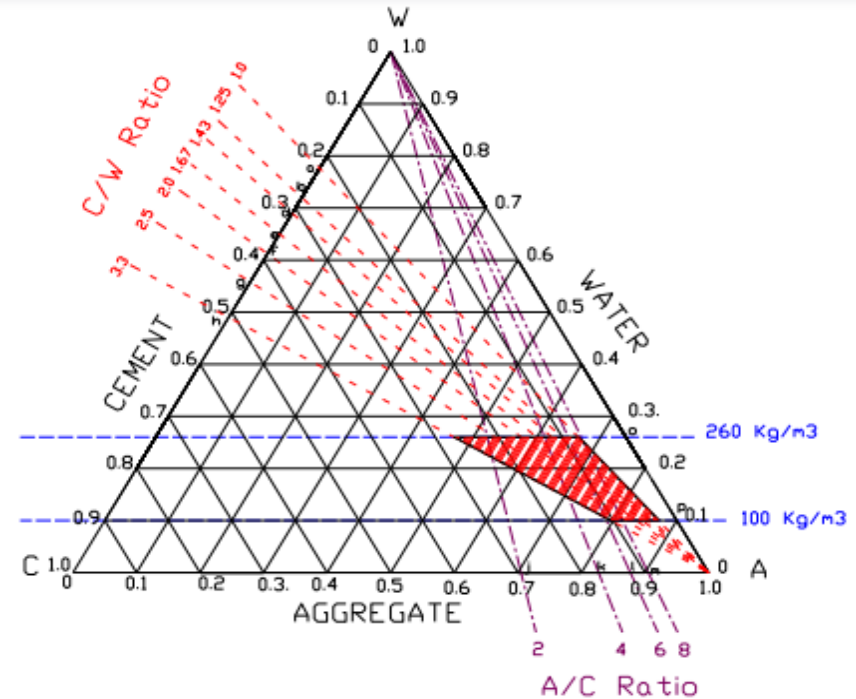
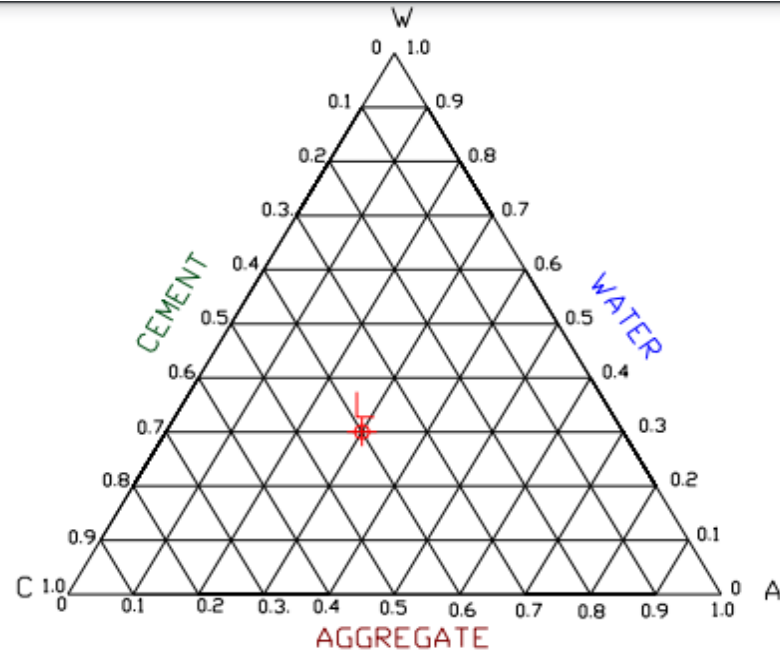
BET specific surface analyzer



Regular batching plant

Steps of PSD optimization

Triangle visualization



In general, to develop families of concrete we apply investigated relations on triangles:

- Firstly on “Cement-Water-Aggregate”, to predict the rational limits in dosage
- and then on “Cement-Coarse Aggregate-Fine Aggregate” to visualize packing density

Steps of PSD optimization

1. Optimization of F.A. <5 mm

- **Minimum voids in sand**

- Find the densest point in a mix (e.g. 22% voids)
- Make some space for a particles to flow (e.g. 23.5% voids)
- Calculate the economy properly

- **Optimum binder content**

- Flow table --> add paste at predicted concrete w/c to the optimized sand till flow will stop increasing

- **Binder can be also packed with fillers (Punkte test)**

- Find maximum density, then shift a bit, move to the best flow

Steps of PSD optimization

2. Optimization with C.A.

- **Minimum voids in >5 mm**

- Find the densest point in a mix between available 2-3 fractions of C.A. in a bigger bucket (at least 15 times wider than man aggr. fr.):
 - Fill bucket with the coarsest, measure voids
 - Add smaller fraction (s), find densest point

- **Combine materials <5mm and >5mm**

- Find optimum ratio between F.A. and C.A. at fixed w/c
- Make some more space for a particles to flow (e.g. reduce intermediate)
- Repeat that steps again to fine-tune your mix if needed