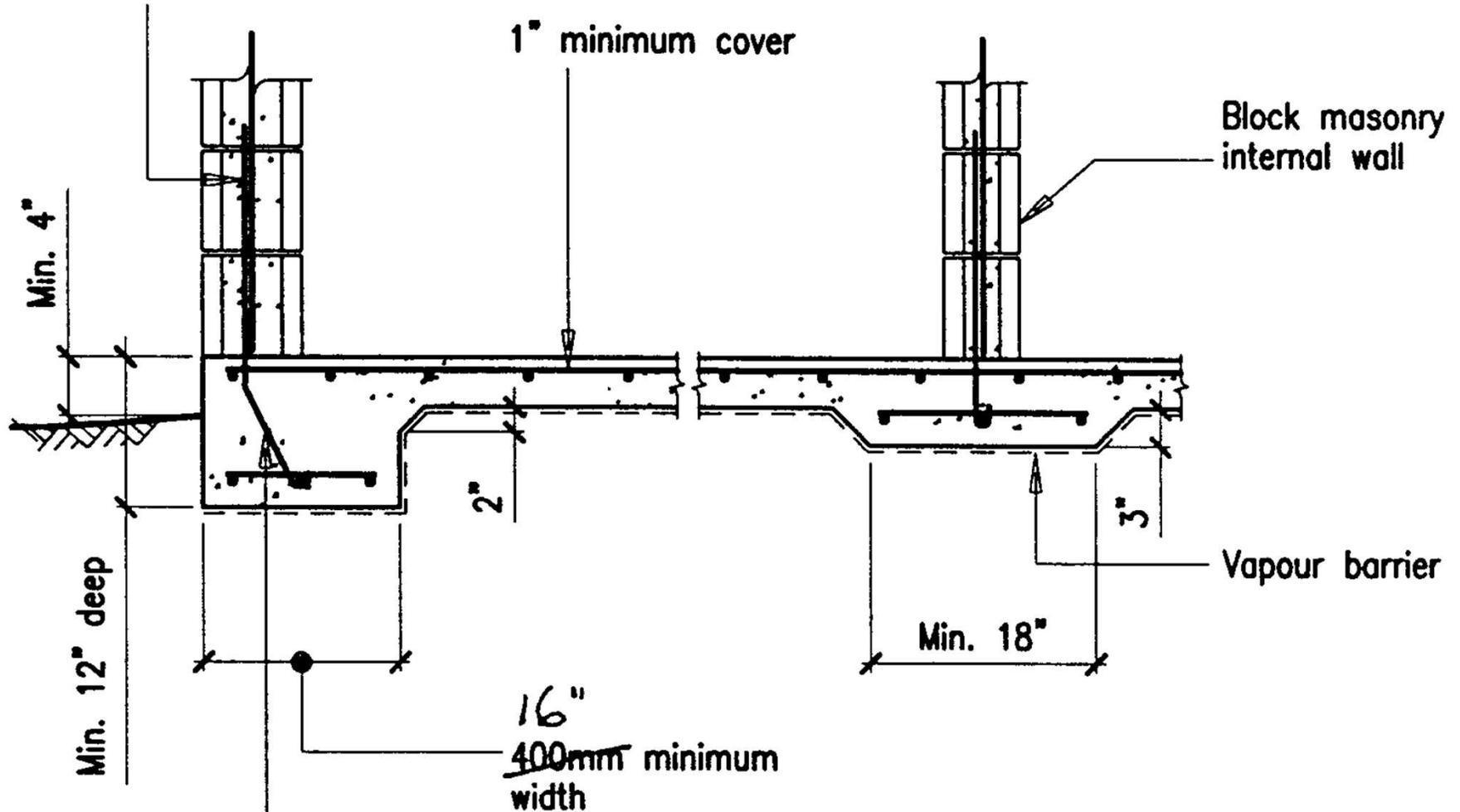
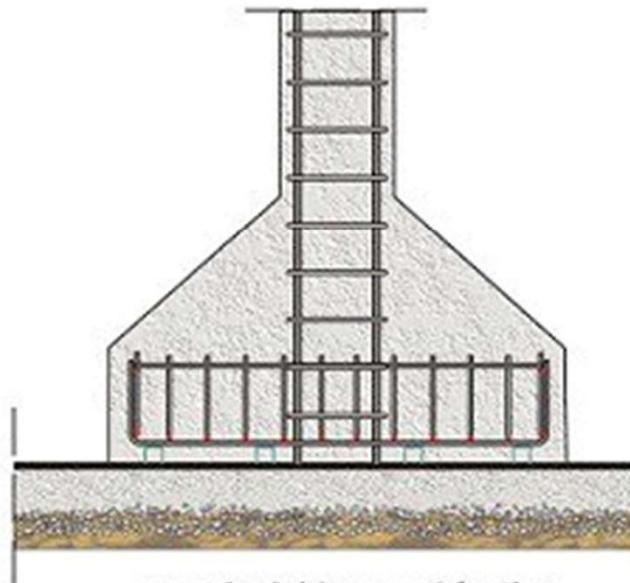


Vertical reinforcement
wired to starter bars

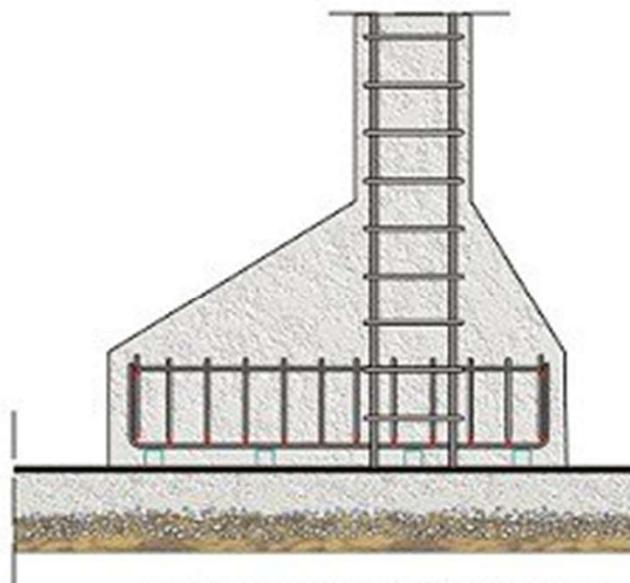


1/2" starter bars
at 32" centres hooked
around reinforcement

Rigid spread footings

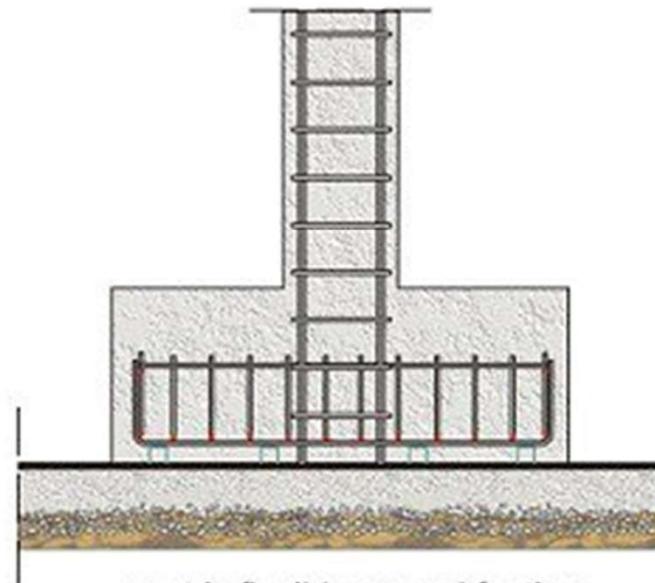


centric rigid spread footing

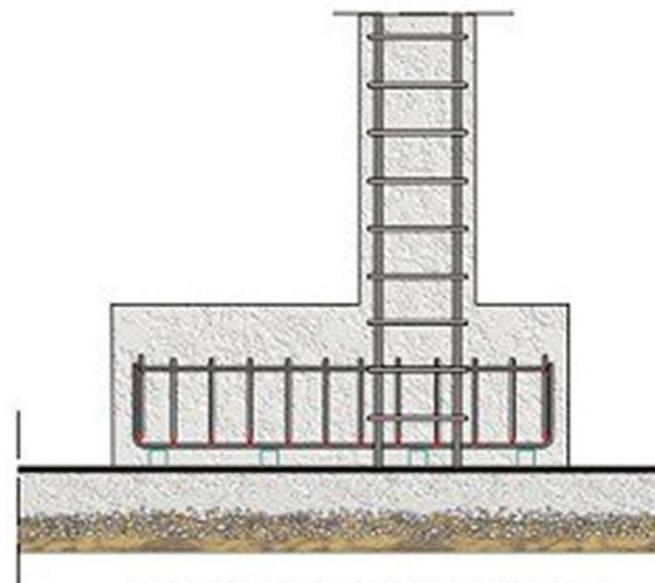


eccentric rigid spread footing

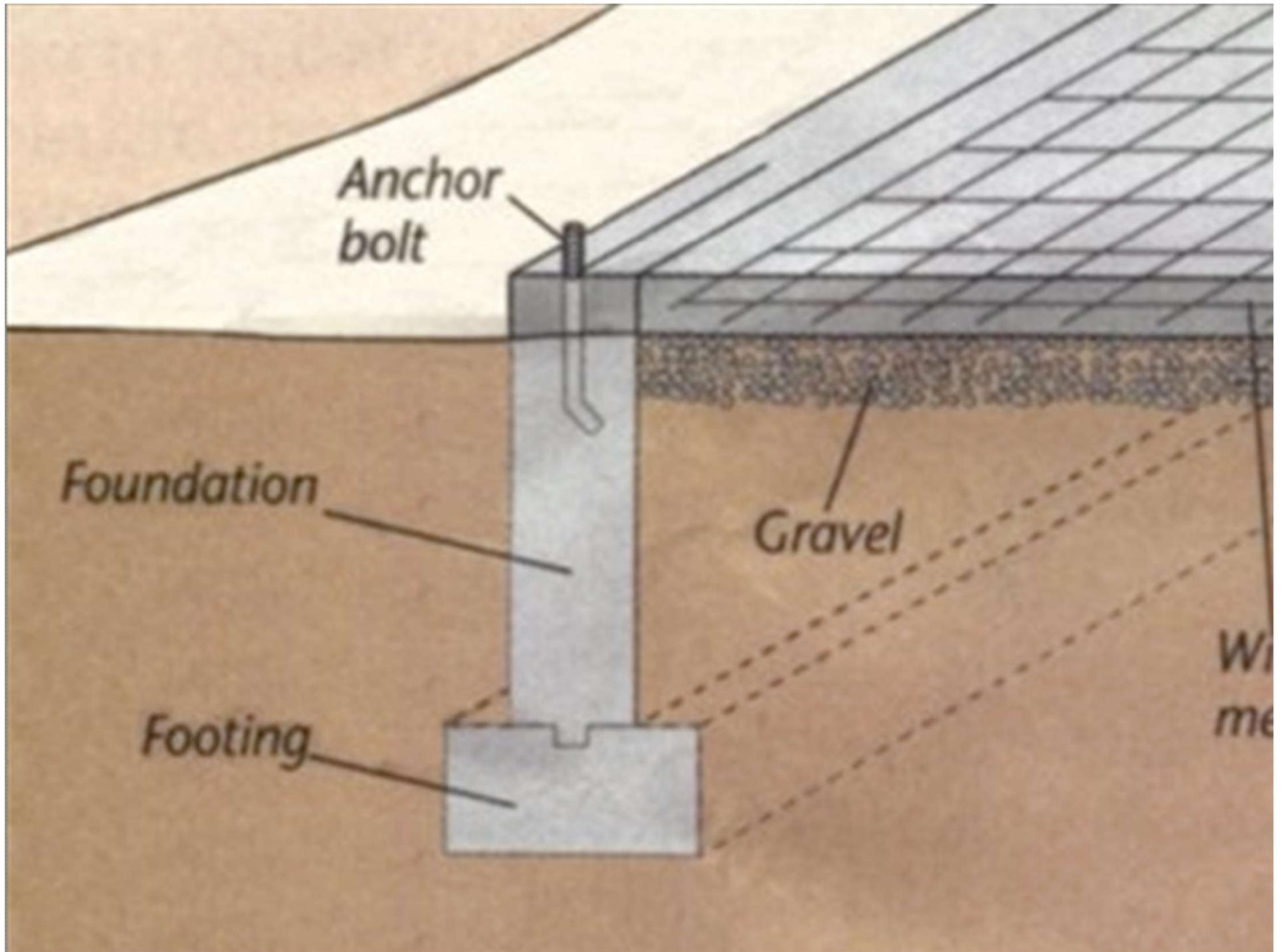
Flexible spread footings



centric flexible spread footing



eccentric flexible spread footing







Concrete Construction

- Portland cement is the most common type of cement in general usage.
 - It is a basic ingredient of concrete, mortar and many plasters.
- English masonry worker Joseph Aspdin patented Portland cement in 1824.
 - It was named because of the similarity of its color to Portland limestone, quarried from the English Isle of Portland and used extensively in London architecture.

Concrete Construction

- Portland cement consists of a mixture of calcium silicates, aluminates and ferrites - compounds which combine calcium, silicon, aluminum and iron in forms which will react with water.

Concrete Construction

- Portland cement and similar materials are made by heating limestone (a source of calcium) with clay and/or shale (a source of silicon, aluminum and iron) and grinding this product (called *clinker*) with a source of sulfate (most commonly gypsum).

Concrete Construction

- In modern cement kilns many advanced features are used to lower the fuel consumption per ton of clinker produced.
- Cement kilns are extremely large, complex, and inherently dusty industrial installations, and have emissions which must be controlled.
- Of the various ingredients used to produce a given quantity of concrete, the cement is the most energetically expensive.

Concrete Construction

- Even complex and efficient kilns require 3.3 to 3.6 gigajoules of energy to produce a ton of clinker and then grind it into cement.
- Many kilns can be fueled with difficult-to-dispose-of wastes, the most common being used tires.
- The extremely high temperatures and long periods of time at those temperatures allows cement kilns to efficiently and completely burn even difficult-to-use fuels.

A few tons of bagged cement. This amount represents about two minutes of output from a 10,000 ton per day cement kiln.



Concrete Construction

- ◉ Combining water with a cementitious material forms a cement paste by the process of hydration.
- ◉ The cement paste glues the aggregate together, fills voids within it, and makes it flow more freely.

Crushed stone aggregate (small).



Concrete Construction

- As stated by Abrams' law, a lower water-to-cement ratio yields a stronger, more durable concrete, whereas more water gives a freer-flowing concrete with a higher slump.
- Impure water used to make concrete can cause problems when setting or in causing premature failure of the structure.

Concrete Construction

- Hydration involves many different reactions, often occurring at the same time.
- As the reactions proceed, the products of the cement hydration process gradually bond together the individual sand and gravel particles and other components of the concrete to form a solid mass.

Concrete Construction

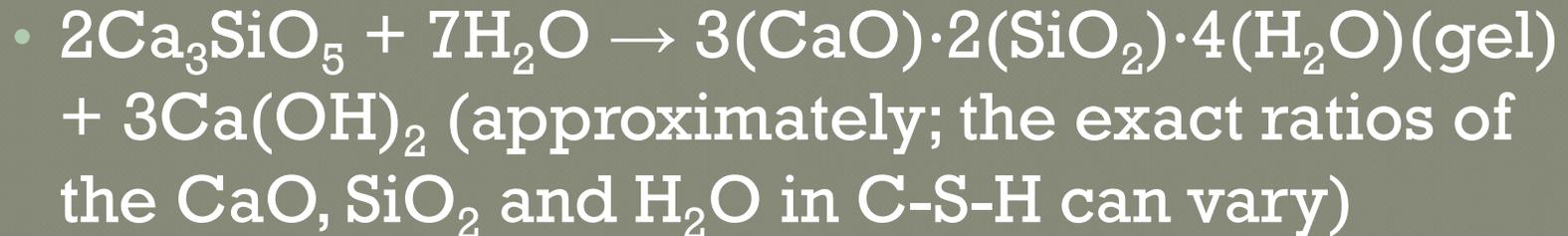
- Cement chemist notation:



- Standard notation:



- Balanced:



Concrete Construction

- Fine and coarse aggregates make up the bulk of a concrete mixture.
- Sand, natural gravel, and crushed stone are used mainly for this purpose.

Concrete Construction

- Recycled aggregates (from construction, demolition, and excavation waste) are increasingly used as partial replacements for natural aggregates, while a number of manufactured aggregates, including air-cooled blast furnace slag and bottom ash are also permitted.

Concrete Construction

- The size distribution of the aggregate determines how much binder is required.
- Aggregate with a very even size distribution has the biggest gaps whereas adding aggregate with smaller particles tends to fill these gaps.
- The binder must fill the gaps between the aggregate as well as pasting the surfaces of the aggregate together, and is typically the most expensive component.

Concrete Construction

- Thus variation in sizes of the aggregate reduces the cost of concrete.
- The aggregate is nearly always stronger than the binder, so its use does not negatively affect the strength of the concrete.

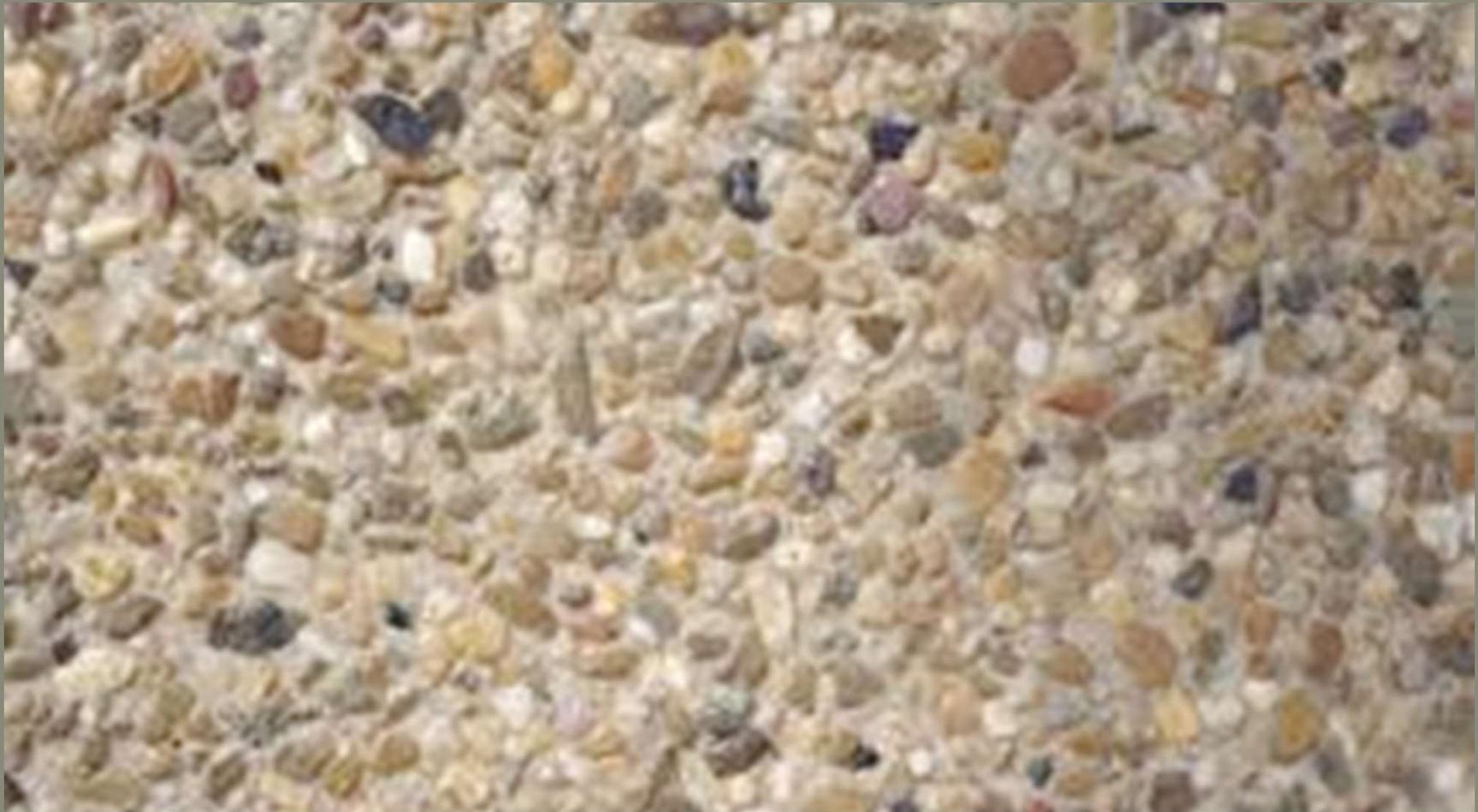
Concrete Construction

- Redistribution of aggregates after compaction often creates inhomogeneity due to the influence of vibration.
- This can lead to strength gradients.

Concrete Construction

- Decorative stones such as quartzite, small river stones or crushed glass are sometimes added to the surface of concrete for a decorative "exposed aggregate" finish, popular among landscape designers.
- In addition to being decorative, exposed aggregate may add robustness to a concrete.

Exposed Aggregate



Concrete Construction

- Concrete is strong in compression, as the aggregate efficiently carries the compression load.
- However, it is weak in tension as the cement holding the aggregate in place can crack, allowing the structure to fail.
- Reinforced concrete adds either steel reinforcing bars, steel fibers, glass fibers, or plastic fibers to carry tensile loads.

Constructing a rebar cage. This cage will be permanently embedded in poured concrete to create a reinforced concrete



Rebar



Rebar Sizes

Sizes

Metric Size	Bar Number	Nominal Size	Weight Per Ft. (lbs.)	Weight Per 20' (lbs.)
10	#3	3/8" (.3759)	.376	7.52
13	#4	1/2" (.5009)	.668	13.36
16	#5	5/8" (.6259)	1.043	20.86
19	#6	3/4" (.7509)	1.502	30.04
22	#7	7/8" (.8759)	2.044	40.88
25	#8	1" (1.0009)	2.670	53.40
29	#9	1-1/8" (1.1289)	3.400	68.00
32	#10	1-1/4" (1.2709)	4.303	86.06
36	#11	1-3/8" (1.4109)	5.313	106.26
43	#14	1-3/4" (1.6939)	7.650	153.00
57	#18	2-1/4" (2.2579)	13.600	272.00

Concrete Construction

- Concrete Mix Designs

- <https://www.concretenetwork.com/concrete-information/>