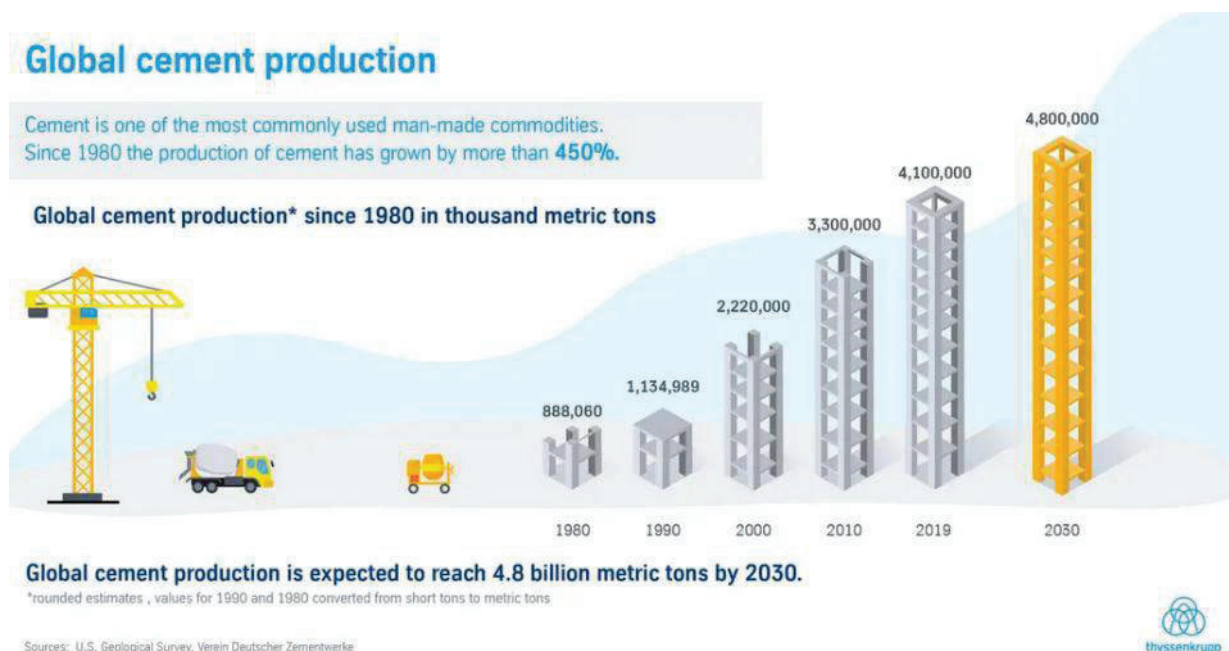


Introduction into the Types of Sand

Sand is the second most sought-after resource in the world after water. The demand for raw materials and with it the amount of mined sand is increasing (*exponentially*). Our planet consumes more than 50 billion tons of sand and gravel every year. More than half of the sand used is for concrete production. That would be enough annually to build a wall 27 meters high and 27 meters wide, encircling the entire planet at the equator.

Sand is defined as an unconsolidated sedimentary rock, resulting from the breakdown of minerals, rocks or organisms, and which takes the form of a fine granule ($0,063\text{--}2\text{ mm}$) accumulation. Sand develops through physico-chemical processes caused by the weathering and erosion of igneous and metamorphic rocks. The components of sand vary depending on the rocks they originate from, the largest part of sand (75-98%) consisting of quartz fragments. The considerable durability of quartz (*measuring 7 on Mohs scale*) makes it resistant to the physico-chemical actions during the erosion processes. If the SiO_2 content of the sand exceeds 95%, we talk about quartz sand. They are constantly worn away by wind or water. However, since the process is extremely slow and much of the sand produced is unusable, it is not a renewable resource. Although the supply may seem unlimited, sand is a quite limited resource altogether. According to UN research, mankind's combined sand consumption - more than 50 billion tons per year - is now more than twice the amount of sediment that is naturally replenished on Earth by the sum of the world's rivers.



Global demand for cement. The demand for sand is 10x the demand of cement.

Hydroformed sand has an uneven shape, so it binds well and creates fine concrete. Desert sand, shaped by wind rather than water, is often unsuitable for building because the desert grains are too spherical to stick well together.

Since sand is created by crushing a wide variety of minerals and rocks under the influence of ambient moisture, wind and temperature fluctuations, the raw materials mined in different places have different properties, which are taken into account when choosing the range of use.

The most important qualitative characteristics that must be taken into account when grading the sand are the following:

a.) ***The shape of the sand grains*** is one of the quality characteristics of the sand, which also affects its selling price. The sand grains created as a result of atmospheric temperature fluctuations are angular and splintered. The corners of rock debris moved by water and wind are rounded off, creating gravel and sand of different shapes and sizes. Rocks with a higher specific gravity give more uniform grain sizes than light shale rocks. Lighter rocks crumble to dust quickly. The harder the rock, the longer the grain resists wear. Round-grained sand is formed only from harder rocks. The shape of the grains depends not only on the method of formation and the quality of the rock, but also on the wear time. That is why river sand is less spherical than beach sand.

According to them, we distinguish four quality groups: spherical (*rounded*), ovoid (*sub-rounded*), angular and fragmented (*sub-angular*) sand.

The construction industry likes to use it, and the metal industry specifically requires spherical sand. This is because the amount of binder required for use and the quality of the resulting cast surface depend on the shape of the sand grains. The more the shape of the grain differs from the spherical shape, the greater the need for binder. For example, a shard-like sand with 10% bentonite gives a mixture with the same strength as a spherical sand with 5% bentonite. Another great advantage of using sand with spherical grains is that concrete with a smoother surface can only be obtained with such sand, because the more fluid the mixture is, the more spherical the sand grains are. Concrete manufacturers, on the other hand, consider coarse-grained river sand to be more valuable. Such material is extremely rare and occurs only in small quantities in one place, therefore it is more expensive.

b.) ***The suspended matter content*** is another quality characteristic of natural sand, according to which the sand can be weak (*1-10%*), medium (*10-20%*) and strongly (*20-30%*) clay. Particles with a diameter smaller than 0.063 mm are called suspended solids. The clay content of a sand also refers to the way the shape of the grains was formed. The quality of natural sand varies from layer to layer. The grains of sand carried by the river water are polar or shard-like, and their content of suspended matter is also higher. The grains of sand rolled by seawater are rounder and their clay content is low, usually varying between 3-5%. At the same time, the silicon content of the floating material is also higher, usually over 85%.

The construction industry uses sand with weak clay content. By washing out the clay and dust, we can improve the physical properties of the sand. This is also necessary because when using a better binder - cement, bentonite, furan resin - the suspended material deteriorates the quality of the mixture. After washing, three qualities can be distributed at the appropriate commercial price: sand with a suspended matter content of 0.25%, 0.5% and 1%.

c.) The third important quality characteristic of washed sand is ***the grain size and degree of uniformity of the grains***. The medium grain size is the size that makes up 50% of the grains in the set. Therefore, its conventional sign is M50. The degree of uniformity means the ratio of particles with a size close to M50, its sign is GU, which is calculated using the following formula: $GU = 4/3 \times M50 - 2/3 \times M50$. The granulation curve is used to calculate the average grain size M50 and the degree of uniformity GU. After washing and

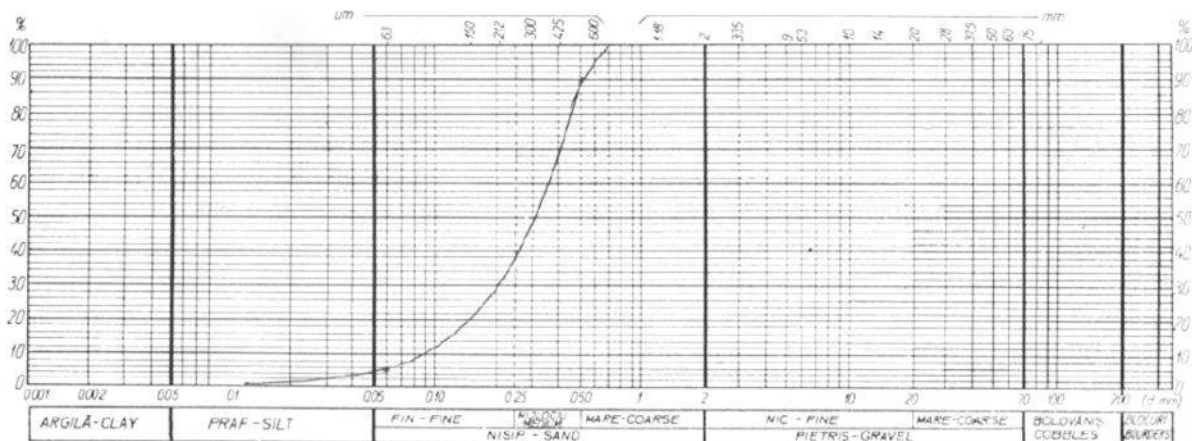
passing through a series of sieves, the grain fractions are weighed. The value of the fractions expressed as a percentage is shown in a table. On the abscissa of the granulation curve, we indicate the grain and sieve size, and on the ordinate the total fractions smaller than the corresponding grain size.

Examples:

- *table 1 contains the distribution of the particles on the sieve of different sizes.*
- *on the abscissa of the granulation curve shown in Figure 2, there is a logarithmic value corresponding to the grain size, namely $\lg D+2$, so that the calculations can be performed in the first quarter of the coordinate system.*

Particle and Sieve Size (mm)	Sand that remained on sieve (%)	Sand that went through the sieve (%)
1.000	3.00%	97.00%
0.630	5.00%	92.00%
0.400	17.00%	75.00%
0.315	15.00%	60.00%
0.200	38.00%	22.00%
0.160	9.00%	13.00%
0.100	7.00%	6.00%
0.063	4.00%	2.00%
dust	2.00%	0.00%

1. table – Particle distribution



2. table – Granulation curve

The size corresponding to 50% of the grains is 0.275 mm, which is the medium grain size M50. On the abscissa, we read the $\lg D+2$ value corresponding to $4/3M50$ and $2/3m50$, which when antilogarithmized gives 0.365 mm and 0.183 mm, which corresponds to 70% and 18% of their values. Thus, the value of the degree of uniformity: $GU = 70 - 18 = 52\%$. This value corresponds to medium quality sand. Sand with a degree of uniformity of 60-70% is considered uniform sand.