



## HOPPER VOLUME AND LOADING CAPACITY

The hopper of a TSHD is characterised by its volume and its loading capacity. In other words: the hopper can be filled with a certain volume of dredged material as long as its loading capacity in tonnes is not exceeded. There is in this respect a difference in the relation between hopper volume and loading capacity for a normal TSHD and that for a gravel dredger. This is highlighted to some more detail below.

Considering the in situ condition of sand and gravel one can say that the pore volume varies roughly between some 45% for fine sands and some 30% for sand with gravel. Also the compactness of soil plays an important role. This means that the density of these saturated soils vary between roughly 1900 and 2150 kg/m<sup>3</sup>. Taking a density of 2100 for the (initially) saturated soil in the hopper of a gravel dredger as an example, this means that one cubic metre of this saturated sand gravel mixture weighs 2100 kg or 2.1 tons.

The relation between the density and the pore volume is as follows:

$$\rho = \frac{100 - n}{100} \cdot \rho_k + \frac{n}{100} \cdot \rho_w \quad \text{in which:}$$

$\rho$  = density of the load (kg /m<sup>3</sup>)

$n$  = pore volume in %

$\rho_k$  = density of the grains (2650 kg/m<sup>3</sup>)

$\rho_w$  = density of the water (seawater: 1025 kg/m<sup>3</sup>)

From this relation it can be seen that if the above saturated soil with density of 2100 kg/m<sup>3</sup> (pore volume about 33%) is dewatered so that 90% of the water is removed, the density is reduced to about 1800 kg/m<sup>3</sup>.

Trailing suction hopper dredgers typically designed for sand and gravel dredging are generally designed for a load density of around 2000 kg/m<sup>3</sup>. This means that in general the gravel dredger will not be overloaded or only slightly, during a short period of time, but that they are always loaded close to their loading capacity.



For a normal TSHD the situation is different: designing for a high density of the load means higher forces on the ship hull and a more expensive dredger.

As the normal TSHD is as well used for the removal of silt layers as for the dredging of sand, the load density for which the dredger is designed is generally a compromise. The average density of silt in the hopper lies in general between some 1200 and 1250 kg/m<sup>3</sup>. When dredging sand however, the density of the (saturated) load of sand will be around 2000 kg/m<sup>3</sup>. So when the dredger is designed for this density, the ship is relatively expensive and the loading capacity is not used when dredging silt. On the other hand when the ship is designed for a density of some 1200 - 1300 kg/m<sup>3</sup> which would be adequate to fill the hopper completely with silt, the hopper could only be loaded to some 60 - 65% when loading sand. As a compromise many TSHD's are designed for a load density of around 1500 kg/m<sup>3</sup>, with a tendency to slightly increase for TSHD's more specially designed for reclamation works.

In order to adjust the hoppervolume to the type (weight) of soil an adjustable overflow is required for normal TSHD's.