TABLE I

Stratum	Consolidation Rate Data												
	Percent Consolidation	0	10	20	30	40	50	60	70	80	90	95	100
	Value of factor N	0	.02	.08	.17	.31	.49	.71	1.00	1.40	2.09	2.80	
1	Time in years	0	.39	1.56	3.3	6.0	9.5	13.8	19.5	27.3	40.6	54.6	
	Settlement, inches	0	2.45	4.9	7.35	9.8	12.2	14.7	17.2	19.6	22.1	23.3	24.5
1A + 2	Time in years	0	.63	2.5	5.3	9.7	15.4	22.3	31.4	44.0	65.5	88.0	
	Settlement, inches	0	1.44	2.88	4.32	5.76	7.20	8.64	10.1	11.5	13.0	13.7	14.4
1A	Time in years	0	.25	.98	2.1	3.8	6.0	8.7	12.3	17.2	25.6	34.5	
	Settlement, inches	0	.94	1.88	2.82	3.76	4.70	5.64	6.58	7.52	8.46	8.9	9.4
Method of Averages	Time in years	0	.95	3.8	8.1	14.7	23.3	33.6	47.4	66.4	99.0	---	
	Settlement, inches	0	2.95	5.90	8.85	11.8	14.8	17.7	20.7	23.6	26.6	---	29.5

No. Z-2 NOTE ON THE PHYSICAL CHARACTERISTICS OF MUD FROM THE ENTRANCE BAR OF THE YANGTZE RIVER

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The delta and estuary channel of the Yangtze River is formed of alluvium brought down by the river in the course of its 3000 miles of travel from N. E. Tibet. Precipitation and erosion is most active in Szechuan, Kueichow, Hunan and Hupeh provinces and it is from those areas that most of the sediment ultimately comes. The charge in suspension rarely exceeds 2000 parts per million and the calculated annual discharge of suspended silt into the Sea is about five hundred million tons. The material deposited in the Estuary is generally a mud, of which the particles are generally less than 1/10 millimetre in diameter so that over 90 per cent of them pass a 200 to the inch screen.

The chemical composition of the sediment is generally as follows:

Silica	70%
Allumina	11%
Iron Compounds	3%
Alkaline Metal Compound	16%

The density of the constituent minerals is about 2.5 to 2.7 (Sporadic patches of fine sand less than ½ millimetre in diameter also occur, apparently due to segregation by currents.)

The density of the wet consolidated silt-mud has the value of about 1.7 to 1.8 indicating that the "voids" are about 50 per cent and that the "porosity coefficient" is about unity. The shearing strength of the settled material is about 150 grammes per square centimetre. (300 lb / sq ft).

The remarkable characteristic of the mud is the ease with which it can be made fluid. Vigorous shaking alone will sometimes make the material fluid with the highly paradoxical result that the Atterburg "plasticity" figure may be negative!

Drag suction dredging on a large scale is now being done on the bar of the Yangtze where most of the material is still finer in grain than the older alluvium on which Shanghai is built. It has been found possible to pump this mud through a 1100 mm suction pipe from a depth of 12 metres below water level and through twin 700 mm discharge pipes to hoppers at a rate of about 8000 cubic metres per hour of diluted mixture with an average density of 1.5 rising at times to 1.6. Whole hopper loads (4000 tons) at mean density of 1.5 have been obtained indicating that less than 40 per cent by volume of dilution water was used (i.e., over 60% of in situ mud in the mixture).

The mixture flows out almost freely from the hoppers when the doors are opened. It is believed that easy pumping of this high density fluid with ordinary mineral constituents is almost unprecedented and indicates that the prolonged grinding processes, involved in the Yangtze silt transport, reduce the sediment to smoothly rounded or flaky grains. These form a mud with low volume of voids, so that when the void volume is only slightly increased the whole mass becomes mobile. The most comparable conditions are those in the Punta Indio at the mouth of the La Plata, but the density of the in situ mud there is only about 1.5, and the dredger builders have not claimed to pump densities exceeding 1.33 (corresponding to 66% in situ material in the mixture).

In the preliminary builder's trials of the dredger made in the approach to Koenigsberg (E. Prussia) the muddy sand there was found to have a bulk density of 1.25 with ordinary mineral constituents. Taking the mineral density as low as 2.5 this corresponds to 84% of voids (porosity coefficient 5.5). Similar voids occur in fairly well packed snow, indicating that a spicular form of grain or honeycomb structure can permit large void volumes.

The range of density and porosity of these three samples all of which behave rather similarly in mud pumps shows how important the investigations of Dr. Terzaghi are in relation to dredging practice.

No. Z-3 STRESS DISTRIBUTION IN DRY AND IN SATURATED SAND ABOVE A YIELDING TRAP-DOOR

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Notations.

s = unit weight of dry or saturated sand
s_o = unit weight of water
φ = angle of internal friction of the sand
$2b$ = width of the trap-door
ℓ = length of the trap-door
H = depth of fill above trap-door
Δh = distance of vertical movement, positive in the downward direction
Q = total pressure of the sand on the trap-door
n_{II} and n_I = normal stress on a horizontal and on a vertical element through a point located above the axis of the trap-door, Fig. 1.
K_o = hydrostatic pressure ratio for lateral confinement (1)
$K = n_{II}/n_I$ = hydrostatic pressure ratio for an arbitrary point located above the axis of the trap-door after the trap-door yielded
$K_r' = \tan^2 (45 + \frac{\varphi}{2})$ = maximum value of Rankine's hydrostatic pressure ratio

Purpose of investigations. A knowledge of the pressure distribution in the sand above a yielding trap-door represents the prerequisite for a clearer understanding of the stress distribution in sand around tunnels. According to the traditional theories of arching above tunnels, including the latest one of A. Caquot (2) the hydrostatic pressure ratio K in the sand located above the roof of a tunnel is equal to the maximum Rankine value K_r'. This assumption appears incompatible with the results of theoretical investigations of the author concerning the process of arching in sands. (3) According to these results the hydrostatic pressure ratio K represents a statically indeterminate quantity with a value intermediate between K_o and K_r'. In order to obtain conclusive information concerning this question, experimental investigations were made by K. Kienzl in the laboratory of the author in Vienna on a trap-door 7.3 cm wide and 46.3 cm long.

Mechanical effect of the yielding of a trap-door. Let us consider a stratum of dry sand, Fig. 1 a, with a unit weight s and a horizontal surface, supported by a rigid horizontal base which contains a rectangular trap-door, aa_1. Before the trap-door changes its original position every part of the base, including the trap-door, is under a vertical pressure which acts like the pressure of a liquid on every part of the base with the same intensity, H_s, per unit of area. However, the slightest downward movement of the trap-door suffices to reduce the vertical pressure onto the door to a small fraction of what it was before. This fact has been known for more than one hundred years.

The mechanics of this transition from the original into the ultimate state of stress are shown in Fig. 1 a and b. As long as the downward movement of the trap-door remains very small it merely produces a vertical expansion and lateral contraction of the lower part of the body of sand, aa_1bb_1, Fig. 1 a, located above the trap-door. As a result of this deformation, the sand located on both sides of this body is allowed to expand laterally, like the backfill of a yielding retaining wall. Since a lateral expansion is always associated with a vertical contraction, shearing stresses develop within two inclined zones, ac and a_1c_1. These shearing stresses transfer part of the weight of the sand located between ac and a_1c_1 onto the undisturbed part of the sand beyond the zone aca_1c_1.

As the trap-door yields still farther, the structure in the sand located immediately above the door disintegrates, owing to excessive expansion, whereupon the planes of minimum resistance shift from the position shown in Fig. 1 a to the boundaries a b and a_1b_1 of the zone of disintegration in Fig. 1 b.