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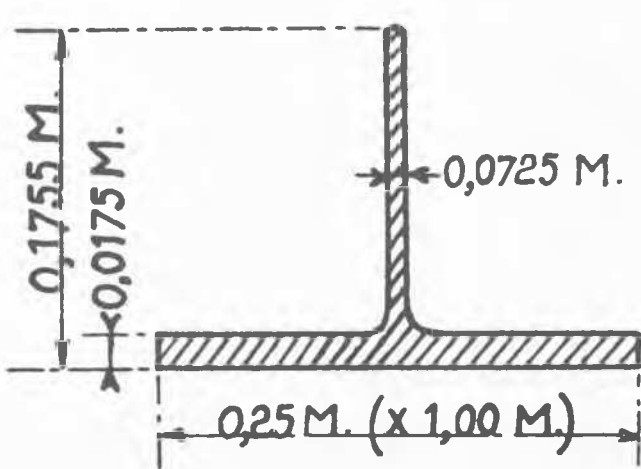


FIG. 7

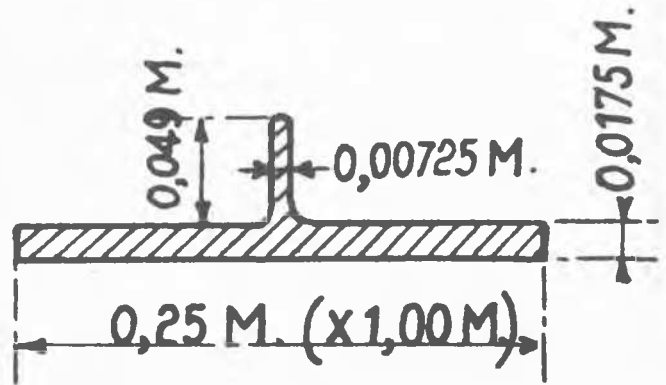


FIG. 8

higher than those of the tests; the values obtained by the method K are higher than those of the parabolic distribution. These results concord again with the theoretical deductions.

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SUB-SECTION VI c

INFLUENCE OF GROUNDWATER

VI c 1

INFLUENCE OF GROUND WATER LEVEL OSCILLATION ON SUBSIDENCE OF STRUCTURES

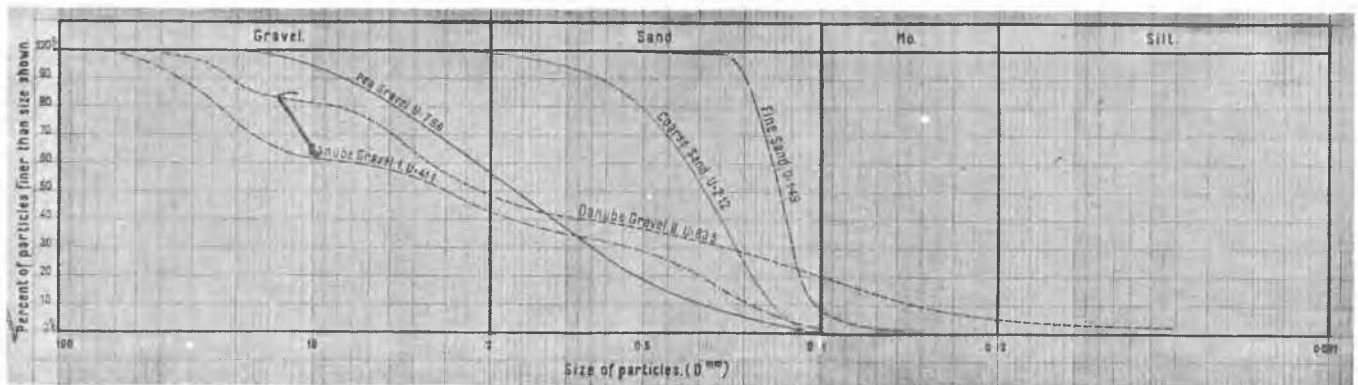
Prof. Dr. JÓZSEF JÁKY

Structures built on loose soil near to rivers suffer suddenly great and unequal subsidence when flooded. In Budapest, in 1940 and 1941, the Electric Works, apartment houses and other structures along the banks of the Danube suffered heavy damages and cracks when the level of the Danube rose over two metres above the flood mark. The author, using an apparatus designed for this purpose (Fig. 1.) determined by laboratory tests the percentage of maximum settling ($\epsilon\%$) of different kinds of granular soils, in relation to load and also the ways of protection. Grain size distribution curves of the tested materials are shown on Fig. 2.

The empirical relations gained by experiments are as follows.

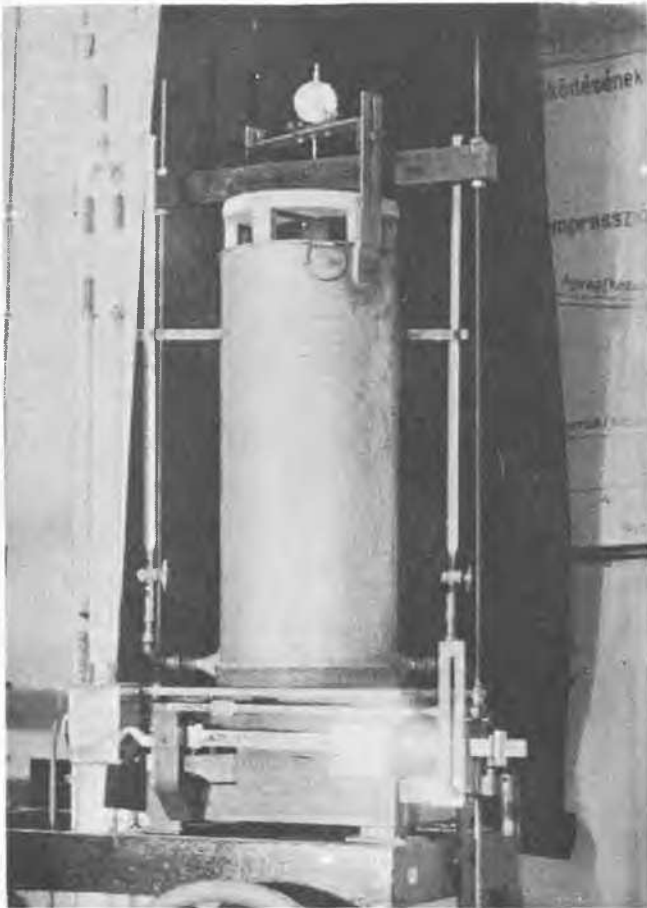
Compressing granular material in the cylinder shown on Fig. 1. with pressure p kg/cm^2 then flooding it with rising water by opening the valve in the lower part of the apparatus, the soil sample ceases to be consolidated and settles under constant load.

1) The specific rate of settling ($\epsilon\%$) varies with the weight of the structure in accordance to Gauss' probability curve. Increasing the load, settling becomes greater, at a critical p_0 kg/cm^2 it reaches the maximum and then diminishes so that if $p \rightarrow 0$ it becomes $\epsilon \rightarrow 0$. (Fig. 3)



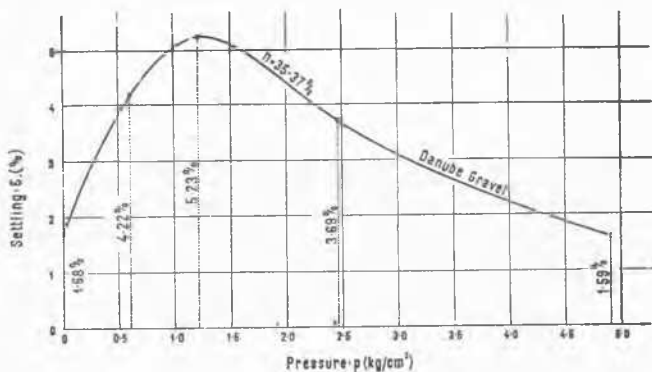
Grain Size Distribution Curves.

FIG. 2



Apparatus for settling tests.

FIG.1



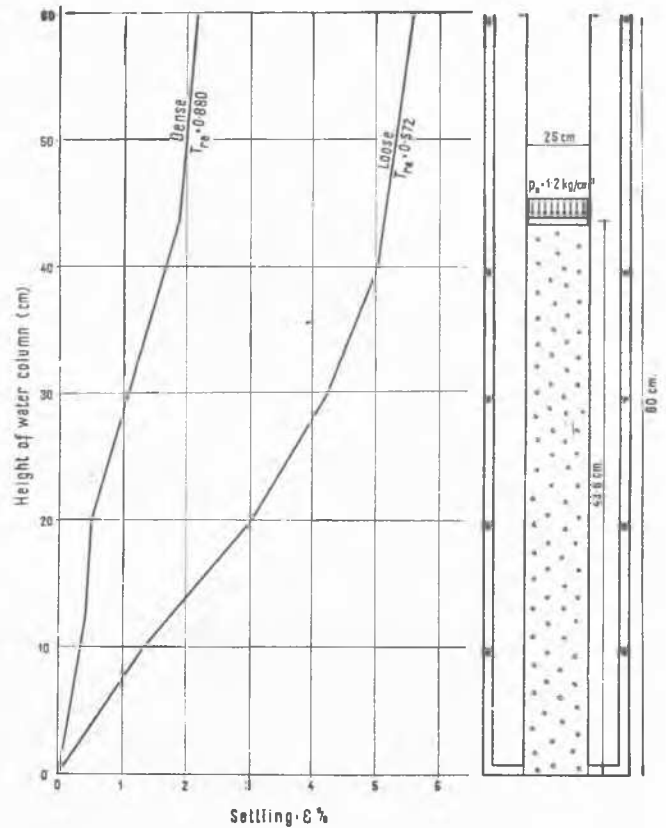
Relationship between settling and static load.

FIG.3

2) While the ground water is rising gradually the percentage of settling - similarly to the consolidation curve - is changing according to a hyperbolic law.

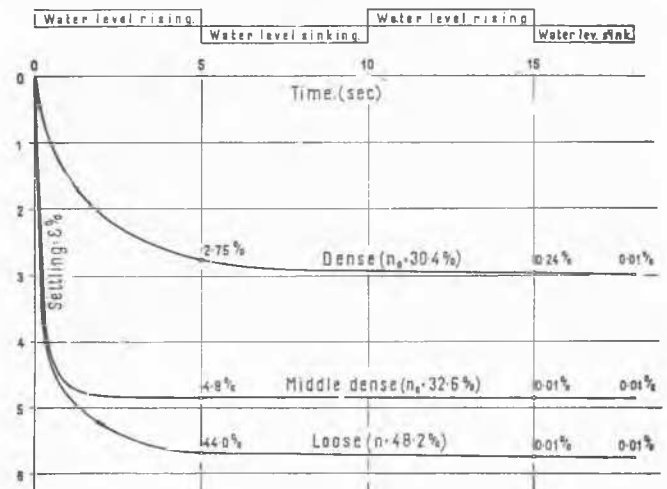
Fig. 4. shows the percentage of settling under the constant load $p = 1.2 \text{ kg/cm}^2$ produced in a gravel cylinder while the water level rose by 10 cm. There was a settling in the loose gravel ($T_{re} = 0.572$) 2 - 3 times as much as in the dense gravel ($T_{re} = 0.880$).

3) Banks of loose gravel which have not been flooded before settle heavily at the first rise of ground water, but flooded repeatedly later, subsidences becomes gradually less mak-



Settling caused by rising water column in dense and loose state.

FIG.4

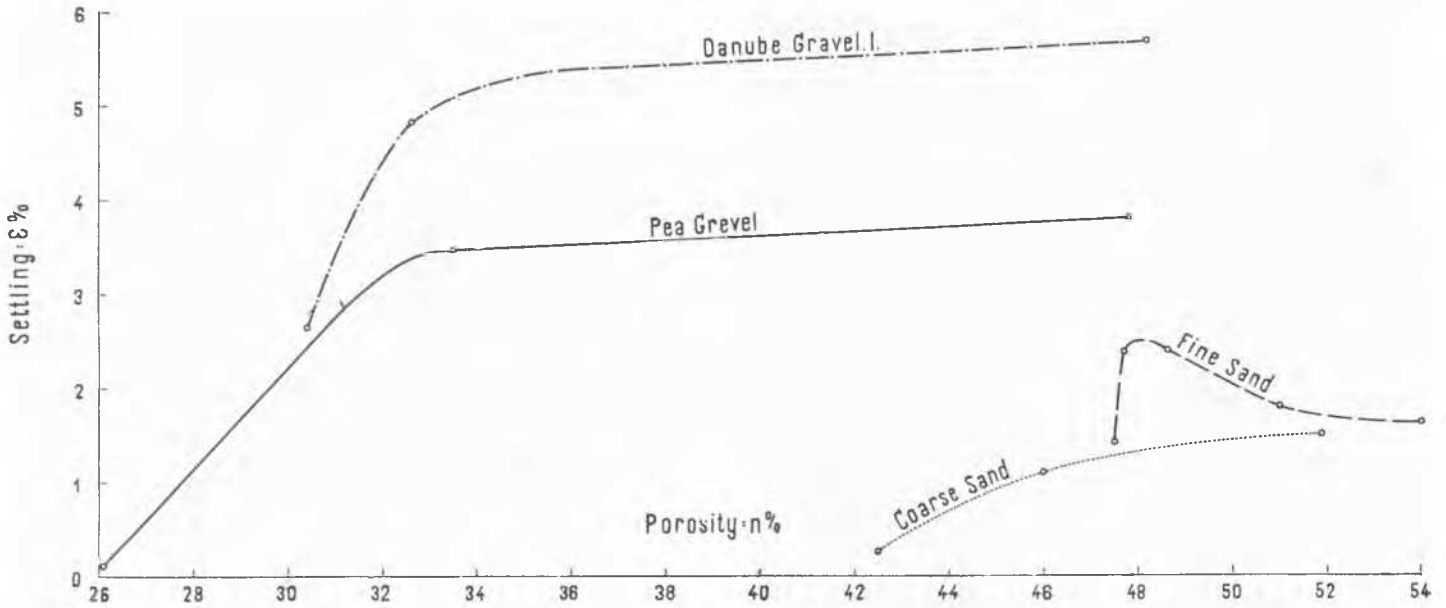


Consolidation curves by various water pressure.

FIG.5

ing 1/10 - 1/100 of the original settlement only. The repeated floodings cause always settling opposed to statements made by L. Erlenbach 1). Thus, after two or three repeated floods the gravel bank piled up loosely may be considered as thoroughly consolidated.

Fig. 5. shows the percentage of settling under constant load $p = 1.2 \text{ kg/cm}^2$ at three different density states for various heights of water column. Water rising in the loose gravel for five minutes produced a decrease of height of 5.7 %, the following water level sinking caused 0.01 % further settling which remained

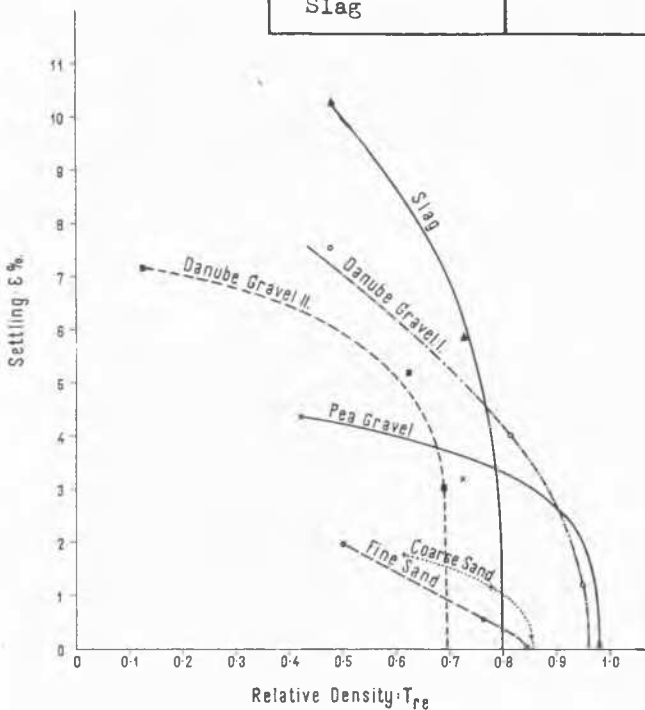


Influence of porosity on settling. (Static load: $P = 1.2 \text{ kg/cm}^2$)

FIG. 6

Optimal relative compactness (T_{re}).

Type of soil	Average size of grain mm	Optimal T_{re}	Settling when loose ($T_{re} = 0.5$) $\epsilon \%$
Fine sand	0.15	0.85	2.0
Coarse sand	0.30	0.85	2.2
Pea gravel	3.0	0.97	4.3
Danube gravel	50 - 0.02	0.96	7.0
Slag		0.80	10.2



Percentage of settling plotted against relative density.

FIG. 7

invariable during repeated floodings.

4) The smaller the void ratio of the earth bank, the less the specific value of settling, but their relationship is not linear (Fig.6)

5) The proper way of protection is thorough compacting before erecting the building. Dealing with the relationship between the relative compactness (T_{re}) and settling ($\epsilon \%$) of different kinds of soils it was found that there is a power parabolic law between them, i.e.

$$\epsilon \% = a (T_{re}^{max} - T_{re})^m$$

wherein a and m are constant (Fig.7)

According to experiments made on different kinds of soils no settling will occur if the relative compactness of the soils are as follows:

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REFERENCES

1) L. Erlenbach, Über das Verhalten des Sandes bei Belastungsänderungen und Grundwasserbewegungen, Degebo, 2. Bericht, S. 46.