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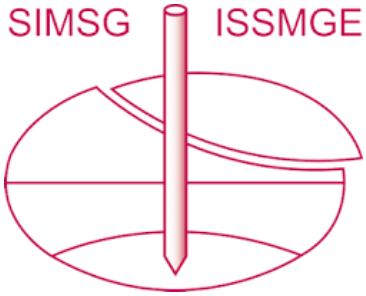

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An Investigation into Vapour Transport in Soil

Etude sur le transport de la vapeur dans le sol

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Summary

The vapour transport through an intermediary layer of sand or gravel to a "binder" has been investigated partly at a constant temperature, partly at a certain temperature gradient in the sample. The vapour transport decreases with the decreasing size of the particles in the intermediary layer. The difference of temperature increases considerably the vapour transport in the direction of the fall of temperature.

Sommaire

Le transport des vapeurs d'eau à travers des couches intermédiaires de sable ou de gravier vers une couche de liaison de grains fins a été examiné, d'abord à une température constante et ensuite à une certaine température, graduée dans l'éprouvette d'essai. Le transport des vapeurs décroît en proportion de la diminution de la grosseur des grains dans les couches intermédiaires. Les différences de température provoquent une considérable augmentation du transport des vapeurs dans la direction de la chute de température.

It has been observed that fine grained soil layers, so-called "binding soil" under destroyed asphalt pavements often have been mingled with water, sometimes, in spite of a capillary breaking layer of coarsed grained material, i.e. sand or gravel. The afflux of water may have occurred through loose parts of the pavement. However, it has been supposed that the water might have been added from underneath by diffusion of vapour. To decide the capacity of this diffusion some experiments have been carried out.

Glass tubes of 30 cm length and 5 cm diameter were filled with different materials. At the top of the tube there was always found a 5 cm thick layer of "binding soil" (the fraction 0.074–0.125 mm). The part of the tube under this layer, on the other hand, was empty or filled with gravel or sand with particles of a certain size. The upper end of the tube was stopped by a metal disc and the lower end, to a length of 1 cm, placed in water.

During the tests some of the glass tubes were placed in a refrigerator. They were surrounded by insulating-cork chips, except at the ends. The metal disc at the upper end of the glass tube was in contact with the air in the refrigerator, which had a temperature of +4° C. The water, in which the lower ends of the tubes were standing, had a temperature of +20° C.

During the tests some of the glass tubes were placed in a room with a fixed temperature of +20° C, which gives the same temperature at both the upper surface and the lower water level.

By packing the soil in the tubes, just before the start of the test, the moisture contents in the air dried soil are defined. Then the tubes are placed in their place for testing.

The vapour pressure over the dry binding soil in the tubes is lower than over the water level at the bottom of the tube, even if the temperature is the same at both points.

However, by experiments in the refrigerator the lower temperature in the binding soil in relation to the temperature over the free water-level makes the difference in the vapour pressure between the two points greater than by constant temperature.

Owing to the difference in vapour pressure we might expect the vapour to pass through the air or the air spaces in the intermediary layer of sand or gravel up to the upper layer of binding soil.

After fixed periods of 1, 10 and 30 days the tests were interrupted and the moisture contents in the soil material defined.

Fig. 1 shows the arrangement for the tests in the refrigerator. The small test tubes over the glass tubes, in which the tests were carried out contain coloured water showing the amount of water, which during 30 days has been transported as vapour from the water level up to the binder soil in the three cases. It can be seen, that the moisture transport in the

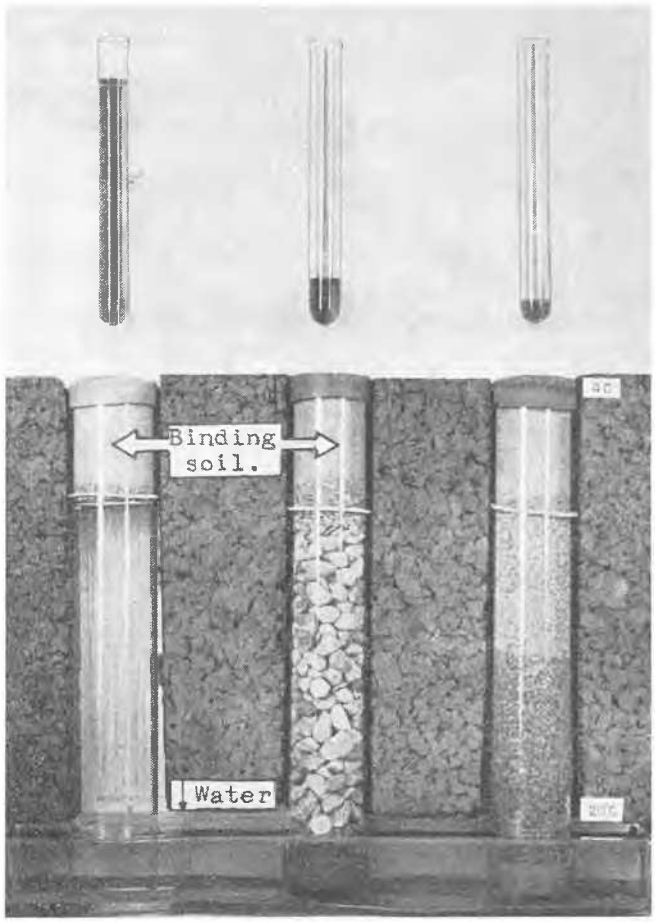

Fig. 1 Principle of the Arrangement for the Tests in the Refrigerator. The Coloured Water in the Small Test Tubes shows the Amount of Water, which during 30 Days has been transported as Vapour from the Water Level up to the Binding Soil
Principe de la disposition des essais au frigidaire. L'eau colorée contenue dans le tube d'essai montre la quantité d'eau qui, en 30 jours, a été transportée sous forme de vapeur de la surface de l'eau à la couche de liaison

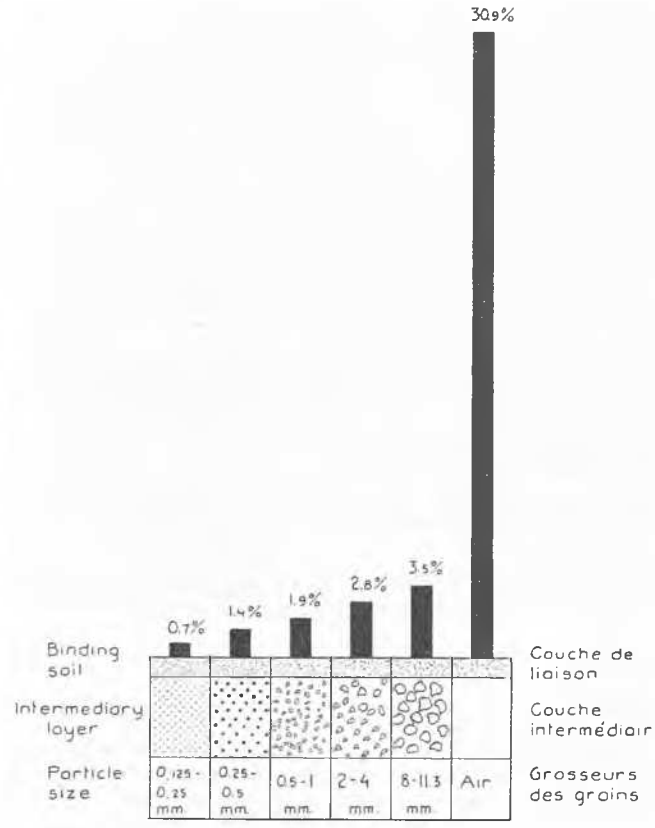

Fig. 2 Moisture Content in the Binding Soil after 30 Days by 16° Temperature Difference between the Ends of the Glass Tubes at Different Intermediary Layers
Humidité contenue dans la couche de liaison après 30 jours d'essai avec une différence de température de 16° entre les deux extrémités du tuyau de verre et les différentes couches intermédiaires

test with no underlying layer is very great in relation to that in tests with an underlying layer of gravel or sand.

Fig. 2 shows the moisture contents in the binder soil after 30 days at different intermediary layers when there is a temperature difference of about 16° between the upper and the lower level of the glass tubes. The diagram shows, that the moisture transport increases with the increasing size of the particles in the intermediary layer.

Fig. 3 shows the moisture contents of the binder soil after 30 days, when there is no difference of temperature in the glass tubes. The moisture transport is in these cases very small when there is an intermediary layer of soil and comparatively great when there is only air between the water level and the binding soil.

The experiments indicate that diffusion through fine grained material the moisture transport will be comparatively small. When the air spaces are so great that convection currents of air can occur, the transport of moisture from the water level up to the binding layer can be great. If the temperature at the top is lower than at the free water level, the transport of vapour is greater than when the temperature is equal at the two points. But even in the latter case the vapour transport is considerable if convection currents take place.

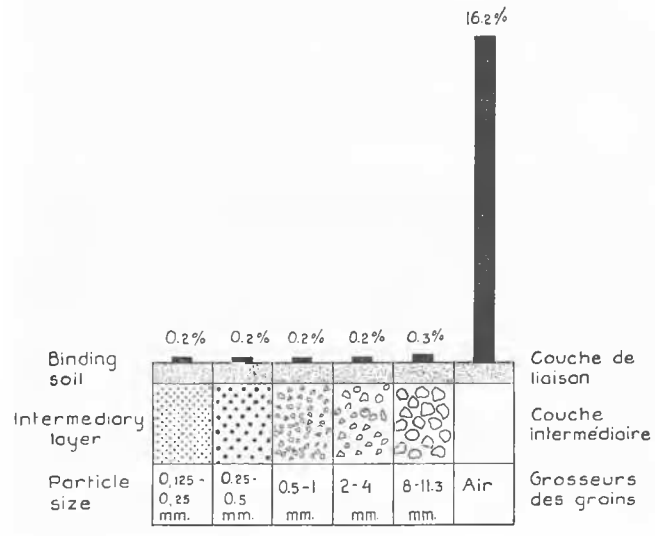

Fig. 3 Moisture Content in the Binding Soil after 30 Days by Equal Temperature (+20°) at the Ends of the Glass Tubes at Different Intermediary Layers
Humidité contenue dans la couche de liaison après 30 jours d'essai avec une température égale (+20°) aux deux extrémités du tuyau de verre et dans les différentes couches intermédiaires