Loading Tests on the Airfield at Beek

Essais de Portance sur l'Aérodrome de Beek

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Summary

During 1947 geotechnical investigations were carried out on the airfield at Beek with a view to the construction of new runways. Along with other tests, the California Bearing Ratio was determined in the laboratory on soaked soil samples.

In 1953 a further research consisting of loading tests on completed runways was undertaken. *In situ* California Bearing Ratio tests were also made, beneath the runway construction and in the field. Results of the *in situ* tests were considerably higher than those obtained in the laboratory on soaked samples, namely 44 per cent beneath the runway compared with 7 per cent for the soaked samples. The loading tests confirm the conclusion that the actual bearing capacity is considerably more than would be expected on the basis of the original CBR data.

Sommaire

Cette communication donne les résultats de quelques essais de portance exécutés en 1953 sur les pistes d'envol de l'aéroport de Beek. Ces résultats ont été comparés avec des recherches faites en laboratoire en 1947, notamment en ce qui concerne l'indice portant californien, mesuré après quatre jours d'imbibition.

L'indice portant californien mesuré en 1953 dans le sol des pistes d'envol et dans le terrain est beaucoup plus haut que l'indice mesuré antérieurement: 44 pour cent en moyenne contre 7 pour cent après imbibition. Ce résultat est confirmé par les essais de portance.

Introduction

During 1947 a site investigation was carried out at Beek airfield in connection with the construction of new runways. After the runways had been constructed further tests were made to investigate the bearing capacity of the chosen construction type, which was a flexible one. These additional tests were carried out because it was considered that the actual bearing capacity would be more than the calculated value. As the design principally originated from the measured CBR of the subsoil and the application of the CBR design curves, it was considered necessary to determine the CBR of the soil beneath the runway construction. Furthermore, a series of loading tests were performed on the runway, which in different parts had a different construction. Though the tests were made on a small scale they led to certain valuable conclusions.

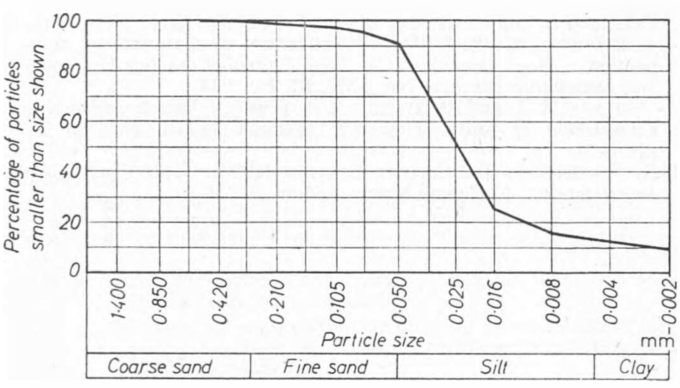

Fig. 1 Grain size distribution curve of the Beek loess
Courbe granulométrique du lœss

Soil Conditions

The upper layers to a depth of 3 to 9 m consist of homogeneous loess; in Fig. 1 a typical particle size distribution curve is given.

Below the loess a coarse sand layer extends to a great depth. The water table lies at about 50 m below ground level. Notwithstanding that, during the 1947 investigations it was observed that the loess to a depth of at least 5 m was nearly saturated with water, as is illustrated in Fig. 2. It appears, from the same figure, that the voids volume is about 40 to 45 per cent. There is a slight increase of it in the upper 1 m, probably due to the effect of freezing and thawing. In the laboratory a sample was frozen; before freezing the water content in the

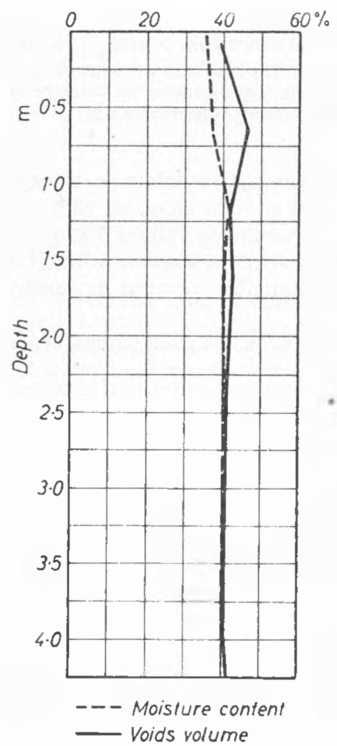

Fig. 2 Measured voids volume and water contents
L'indice de vide et la teneur en eau mesurée

frozen part was 28·7 per cent and this volume was increased to about 36·0 per cent after freezing.

The results of a Proctor test on a sample of the soil are given in Fig. 3. The test was made according to the modified AASHO method. The loess was compacted in a 4·59 in. high cylinder, diameter 4 in. with a 10 lb. rammer dropping from a height of 18 in. The sample was compacted in five layers of equal thickness, each layer being compacted by 25 blows.

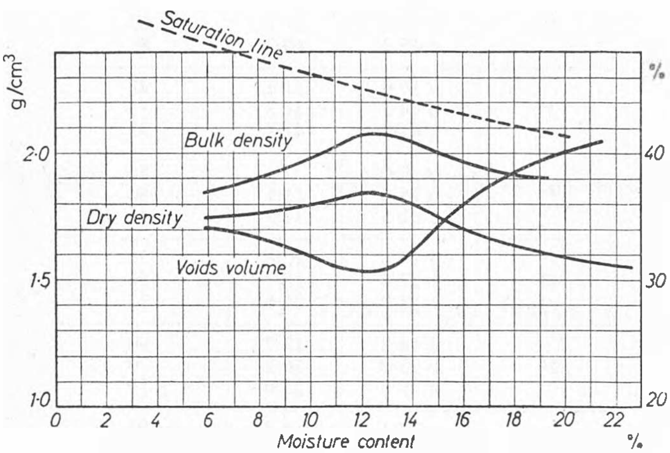

Fig. 3 The result of a compaction test
Le résultat d'un essai de compactage

As can be seen from Fig. 3 the water content at maximum compaction is about 12·0 per cent. This is considerably lower than the natural water content, which is about 40 per cent.

CBR Tests

During the 1947 investigations a series of CBR tests were made on samples tested in the laboratory after four days of soaking. The results are presented in Table 1.

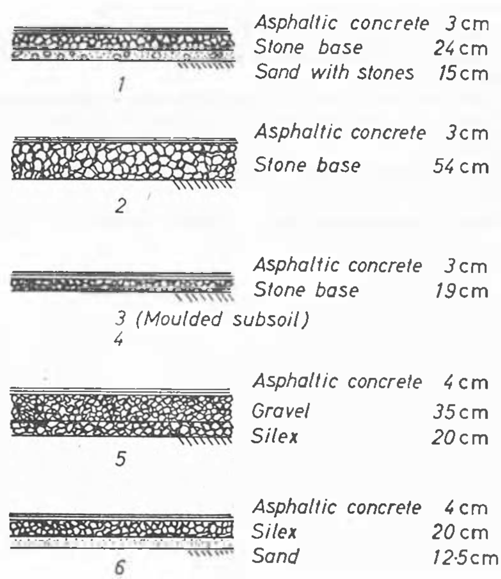

Fig. 4 Types of construction tested
Types différents de pistes d'envol soumises à l'essai

On an average the CBR of the samples 1 to 6 amounts to about 7 per cent.

During the summer of 1953 a number of CBR tests were performed at the airfield. These differed with the previously mentioned samples by the fact that no samples were taken but that the tests were performed *in situ* and not soaked. Some of the tests were made below the runway construction, the others were made in the field. The results are given in Table 2.

Table 1

Sample	*Depth* m	*Bulk density* g/cm³		*Voids volume* %	*Water content* %		CBR %
		Before sat.	*After sat.*		*Before sat.*	*After sat.*	
1	0·15	1·89	—	40·5	31·4	—	10·2
2	0·15	1·83	1·89	43·1	32·2	38·0	4·2
3	0·15	1·91	1·95	39·2	29·9	34·0	9·3
4	0·15	1·69	1·77	48·8	33·0	41·0	2·0
5	0·15	1·95	—	38·5	31·3	—	10·4
6	0·15	2·02	2·04	37·1	35·4	37·0	11·6
7*	0·15	1·99	2·05	33·2	21·6	28·0	40·0

* Sample compacted in laboratory

Table 2

Sample	*Depth* m	*Bulk density* g/cm³	*Voids volume* %	*Water content* %	*Degree of saturation* %	CBR %
Beneath runway:						
8	0·30	1·87	36·7	27·1	73·8	24·3
9	0·30	1·87	36·7	27·1	73·8	33·3
10	0·30	1·82	36·9	23·0	62·3	41·5
11	0·30	1·82	36·9	23·0	62·3	67·0
12	0·30	1·82	36·9	23·0	62·3	71·2
In the field:						
13	0·30	1·97	32·1	26·2	81·6	37·5
14	0·30	1·92	34·3	25·9	75·7	31·1
15	0·30	1·99	32·5	28·8	88·6	20·3
16	0·30	1·95	33·5	27·4	82·0	25·0

First of all there appears to be a considerable difference between the average CBR of the subgrade beneath the runway (equal to 44·4 per cent) and of the soil in the field (equal to 28·5 per cent). This difference would probably have been considerably more if the weather during the 1953 research had not been very dry and hot.

A further analysis of the measured voids volume and water content shows that the CBR probably is most influenced by the saturation of the soil. Table 2 indicates that in the cases with the most saturated soil the lowest CBR was obtained. Also, from a practical point of view, it was already known that loess is very sensitive to the water content. Therefore it appears to have been wrong, in this particular case, to soak the soil samples four days before determining the CBR. As a result the average CBR, obtained in this way, of 7 per cent, is much lower than the CBR which was in reality measured beneath the constructed runway, being about 44 per cent on an average. Consequently, the bearing capacity of the runway is far more than expected on the basis of the original tests.

Loading Tests

Loading tests were made at six different places on the runways. The types of construction tested are shown in Fig. 4. The difference in the types used resulted partly from the levelling of the site to the required formation and partly from the wish to try out these different types.

With the aid of a 50 cm and 75 cm circular plate a series of loadings and unloadings were applied. Each load was repeatedly exerted and removed before a new increased load was applied. As a result, load–settlement–time curves were obtained of the usual type. With the aid of them it was possible to compute the bearing capacity according to: the Highway Research Board Method; the McLeod Method; the Schiphol Method (BRZESOWSKY and VAN DER VEEN, 1953).

The results are given in Table 3. The load–settlement curves at first loading are shown in Fig. 5.

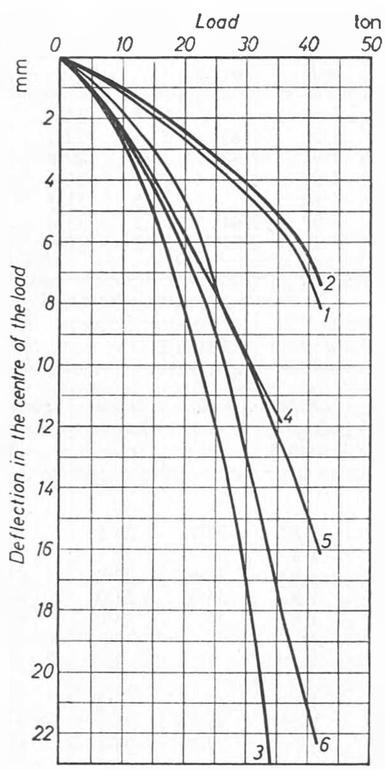

Fig. 5 Loading tests on the runway constructions
Essais de chargement sur les pistes d'envol

The results of the loading test confirm the conclusion arrived at already on the basis of the CBR tests.

Conclusion

Though relatively only a few tests have been made, it may be stated that in this particular case the CBR values obtained on soaked samples gave an under-estimate of the bearing capacity of flexible runways.

Table 3

Loading test	*Allowable single wheel load* ton		*Allowable load on taxiways as % runways load*
	Runways	*Taxiways*	
1*	a 26·1 b 41·5 c 45·2	23·5 27·1 40·3	90 65 89
2*	a 37·0 b 44·1 c 45·9	31·2 31·3 41·7	93 71 91
3*	a 9·0 b 15·0 c 21·5	7·6 12·1 17·9	84 80 83
4*	a 17·0 b 27·4 c 31·9	12·6 15·2 24·6	74 56 77
5*	a 14·2 b 23·0 c 29·0	12·7 16·2 23·0	90 70 79
6†	a 14·1 b 21·7 c 25·2	12·4 14·1 20·6	88 65 82

* 75 cm diameter plate
† 50 cm diameter plate
a = Highway Research Board method
b = Schiphol method
c = McLeod method

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