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The planning and design of the new Hong Kong Airport †

by

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Discussion

The following contributions were received in writing.

Mr S. B. W. Webb (Central Laboratory, George Wimpey & Co. Ltd) referred to the C.B.R. method of design. The approach illustrated in Fig. 14 seemed to be a useful one for sites where very low C.B.R. values were encountered, for the L.C.N. method of assessing the equivalent single wheel load did not take account of the depth to which the load was acting. Whilst the Authors' method seemed desirable for very soft subgrades, could it not also offer economies where rather better subgrades existed?

217. Could the Authors give more information about Fig. 15? Mr Webb believed that in tests done in connexion with earlier work at Kai Tak, some difficulty had been encountered in eliminating the effects of excess pore-water pressure in the C.B.R. specimens. He inferred that the Authors were satisfied that that problem had been overcome, but would like to have details of the time found to be necessary for the pore pressure to dissipate.

218. The lines of constant C.B.R. for the dry end of the lower C.B.R.s were well below the compaction curves shown. Were they estimated C.B.R. values, or could the Authors show further compaction curves, or individual points, and with what compactive effort?

219. Finally, the Authors had shown that in one particular case the effect on the C.B.R. of soaking the sand was small, whilst in another case the effect of soaking decomposed granite was large. The common features of both cases seemed to be that the dry density was unaltered or dropped very slightly, whilst the moisture content increased until the air-voids content was about 3 or 4%; the C.B.R. after soaking conformed more or less to the values indicated by the lines of constant C.B.R. Had the Authors sufficient information to confirm that the changes were general, and did the lines of constant C.B.R. give any information concerning the C.B.R. after soaking? If those lines did give an indication of the C.B.R. after soaking, it would enable the rather lengthy soaking to be eliminated.

Mr J. J. Bryan (Partner, Scott & Wilson, Kirkpatrick & Partners, Consulting Engineers) referred to Fig. 6 and the twenty parking bays shown on the apron. In § 1 the Authors had stated that they hoped to submit another Paper dealing with items not yet finally designed and with the construction of the Airport; Mr Bryan asked if the twenty bays were shown as they would finally be or if the layout shown was tentative only. When the design of the terminal apron for the new Singapore Airport, which was provided with a hydrant-type refuelling system, had been under consideration, the spacing of the groups of hydrants presented a considerable problem, for an attempt had been made to

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make it possible for jet aircraft to enter and leave a bay under their own power without damaging the terminal building or aircraft parked in adjacent bays. As a result of information then available it had been decided to place the groups of underground hydrants a little more than 200 ft apart. In the design of the aprons for Hong Kong airport, had consideration been given to making the width of the parking bays suitable for the use of jet aircraft moving under their own power; if so, what conclusions had been reached?

221. An interesting Australian design put forward some years ago had incorporated a slope of 2 to 3% on the terminal apron to enable jet aircraft to start off on their departure from the terminal under the force of gravity. Any information which the Authors could give on that subject would be of great interest to engineers responsible for designing terminal aprons incorporating hydrant-refuelling systems.

The Authors, in reply, observed that Mr Webb had referred to the design curves illustrated in Fig. 14 which had been developed from the standard C.B.R. design curves and had called for a comparison with the L.C.N. method of design. When applying the L.C.N. method of design to pavements supporting a multiple-wheel undercarriage it was necessary to determine the equivalent single-wheel load corresponding to the multiple-wheel undercarriage in question. It was generally appreciated that the equivalent single-wheel load varied with the strength of the subgrade and the thickness of the pavement consequently required. That variation led to complications in the design methods.

223. A very approximate solution to the problem had been made by assuming a value for the equivalent single-wheel load based on average conditions. The information on equivalent single-wheel loads given in Table B2 of Annex 14 of the I.C.A.O. International Standards and Recommended Practices was based on that assumption. That resulted in under-design where a weak subgrade was encountered and to over-design where the subgrade was strong. The design curves, as shown in Fig. 14, were developed from a study of the vertical stresses set up in the pavement and the subgrade by a particular multiple-wheel undercarriage. They did not involve the determination of the equivalent single-wheel load. For that reason the Authors considered that those curves were likely to give more realistic pavement thicknesses for weak or strong subgrades than design methods involving isolated single-wheel loads which had been assessed, assuming average conditions.

224. Mr Webb had raised a number of interesting points concerning the C.B.R. information given in Fig. 15. Some years previously the Authors had carried out an investigation with decomposed granite with a view to studying how the C.B.R. of that material varied with its dry density and moisture content. They had found during the investigation that the C.B.R. of that soil depended not only on its density and moisture content but also on the state of the water in the voids. The investigation had indicated that when a soil was compacted so that the air voids were reduced to 5% or less pore pressures tended to be built up in the water in the voids. It had been found that if samples were tested immediately following compaction a low C.B.R. resulted, whereas if the sample was allowed to stand covered by a damp cloth to prevent drying out and then tested a much higher C.B.R. was obtained although the density and moisture content remained virtually unaltered. That increase in C.B.R. was attributed to the dissipation in pore pressure which could take place with a negligible change in moisture content. The investigation had indicated that 12 hours was usually sufficient to dissipate the pore pressure in samples of decomposed granite. The speed of dissipation obviously depended on the permeability and the time for dissipation with fat clays would be very much longer.

225. The lines of equal C.B.R. which had been plotted in Fig. 15 had been obtained by determining values for the C.B.R. at various points on the dry-density moisture-content curves obtained when using British Standard and modified A.A.S.H.O. methods of compaction. Knowing the general shape of the lines of equal C.B.R. which had been determined from the earlier investigation, and the values of the C.B.R. at specified points on the B.S. and modified A.A.S.H.O. curves the lines of equal C.B.R. had been drawn. They were, of course, approximate, but gave a picture of how the C.B.R. varied

with the dry density and moisture content, assuming that the pore pressures had been dissipated.

226. Referring to the question of soaking, the two samples referred to in Fig. 15 which had been subjected to soaking had resulted in the moisture content increasing until air voids were reduced to 3 or 4%. In cases where the compacted soil was reasonably permeable the Authors thought such a result could be expected. The Authors did not think that the investigation had shown that the reduction of the air voids to 3 or 4% by soaking was general. With soils of low permeability the effect of the 4-day soaking test was likely to be very much reduced. They considered that further research was required into the C.B.R.s of compacted soils having air voids of 5% or less and they hoped that such research might ultimately lead to the elimination of the unsatisfactory and lengthy soaking tests which now had to be carried out.

227. Mr Bryan had raised the question of aircraft stand sizes, with particular reference to the spacing of pits for a hydrant refuelling system. The design of the outer row of double-entry stands shown in Fig. 6 did not present much difficulty. To allow for future stretch in aircraft wing spans, the width of those stands had now been increased from 165 to 175 ft with a corresponding reduction in the dimensions of the refuges. It had been agreed with the fuel companies that a single row of hydrants down the centre-line of the stands would serve to refuel all types of aircraft whether they were parked facing the terminal building or Kowloon Bay. On the other hand, the design of the inner stands involved problems in the parking of jet aircraft which had hitherto been unresolved. The Ministry of Transport and Civil Aviation had done much useful research on the most suitable nose-wheel guide-lines and angles of parking for all piston-engined and turbo-prop aircraft. Their recommendation for the largest of the aircraft, including the Bristol Britannia, was a stand size of 300 ft. Now that information was available on the turning radius and undercarriage dimensions of the Boeing 707 and Douglas DC8 it was relatively simple to extend the Ministry's principle of design to embrace those aircraft. Working on a wing-tip clearance of 15 ft on entry and exit from a stand, a stand length of 220 ft was required. That stand size, however, did not include any special clearance for jet blast, and the limited information available on the subject indicated that an additional clearance would be required. A suitable size of stand for a jet aircraft operating under its own power could not be determined until more was known about blast. It might well be that the length of stand required would be so great, or the noise level of jets taxiing so high, that they would have to be towed. The question then arose as to whether they might with advantage be parked with the nose facing the terminal building; they could taxi in under their own power, and a stand length of 200 ft would be adequate.

228. The Authors understood that the work of the I.C.A.O. Jet Operations Requirements Panel included the study of parking jet aircraft, and they hoped that the problem would be satisfactorily resolved before a decision was necessary on the siting of fuel hydrants and other fixed services on the apron.

229. Consideration had been given to sloping the apron in order to reduce the thrust necessary to set an aircraft in motion on leaving a stand. It was decided, however, to work to minimum grades on the apron and in the maintenance area, in view of the very heavy draw-bar pull that would be required to tow future airliners up a gradient.

230. Finally the Authors wished to draw attention to some misprints in their reply to the discussion. Details are given on p. 198 of the October 1957 Proceedings.