Discussions

Comparative Studies of Field and Laboratory CBR Results*

by

J.M. Kate

V.K. Tokhi**

The writer appreciates the work of the Author which will be of use to the Soil and Highway Engineers in and around the area where soils with similar characteristics exist. The author has come to the conclusion that the CBR determined in the field is always higher than the CBR determined in the laboratory for the same soil under identical conditions of test with regard to density, degree of saturation and procedure of test. $(CBR)_{lab}$ has been found to be higher than $(CBR)_{field}$ by between 20 to 50 per cent, the average reported value being 35 per cent. The author attributes this to confinement of laboratory specimen in the mould. Whereas confinement of laboratory sample which is surely several times the confinement available to soil in the field, particularly for low CBR values and is therefore an important factor, the following points may also require careful consideration.

(*i*) The loading frame jack and the dead weights kept for reaction weights in the field on the equipment might weigh more 100 kg and thus provide additional confinement to the field specimen in addition to that which is available from soil itself and also the guide weight. This will be a function of distance of legs of loading jack from the CBR—smaller the distance larger the confinment. It may probably be better to use a loading equipment which does not alter the stress distribution within the virgin soil. An equipment shown in Figure 1 which is mounted at the rear of a truck may be useful (the minimum distance of truck wheel from the plunger may be over 1 m). This has been used by the writer for field determination of CBR (Tokhi 1974).

(*ii*) The Author reports that after 48 houre of submergence the soil specimen collected for determination of moisture content showed 100 per cent degree of saturation. The method used for submerging the site of test and the depth from where the specimen was collected is not mentioned. The minimum depth at which this checking should be done must be deeper than the depth which is involved in deformation as the plunger penetrates its full stipulated depth of 5 mm. This depth should be about 2 to 2.5 times the plunger diameter or 10 to 12.5 cm. If undisturbed sample is collected from the same place depth of saturation should be about 17.5 cm. Now assuming that the flow commences at an initial head of 15 cm. which falls to 1 cm. at the end of 24 hours. The head is brought back to 15 cm. after this and falls to 1 cm. at the end of

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* Published in Indian Geotechnical Journal Vol. 10, NO. 3, July 1980.

** Assistant Professor in Civil Engineering, M.A.C.T. Bhopal-7, India.

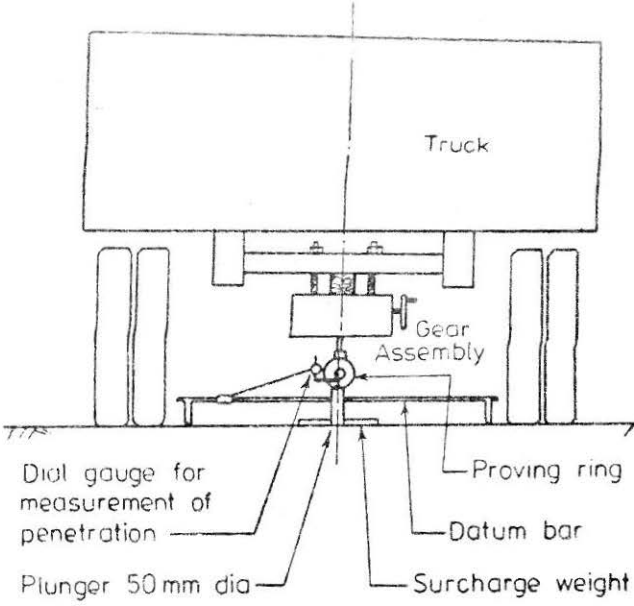

FIGURE 1 Track mounted CBR opporatus

24 hours (total time 48 hours), then total depth of flow of water would be 17.5 cm if the permeability of the soil is at least 2.70×10^{-4} cm/sec. (calculations based on theory of falling head permeameter). This assumes that the soil is initially saturated and that no flow of water takes place in the radial direction. Hence the actual time required for a depth of 17 5 cm to get saturated will be more than 48 hours. When the actual permeability of soil is less than 2.74×10^{-4} cm/sec which is the case with as many as 8 test sites (out of 20), the saturation will be incomplete.

With regard to the second conclusion that is the pocket penetrometer readings must be used with caution as they do not represent the true values. An analysis of Figure 4 of the author shows that when CBR < 5 the maximum error occurs at field penetrometer resistance of 3.8 kg/cm^2 when actual field CBR is 2.6 while from the laboratory curve a value of 3.5 is obtained. This variation is also 35 per cent. Beyond CBR of 5.0 the use of penetrometer resistance will result in error on safe side.

Thus use of penetrometer resistance can result in maximum error of 35 per cent while the maximum error in $\frac{(CBR)_{lab}}{(CBR)_{field}}$ is 52 per cent (with respect to test number 13). Hence reliance on penetrometer resistance is likely to result in smaller error and it is much easier and quicker to obtain a penetrometer reading than conduct a CBR test.

In addition to the authors comments illustrated in Figures 2, 4, 5, 6 and 7 of the paper following more observations can be made

1. There is a linear relationship between the field CBR and cohesion. This is shown in Figure 2 below.

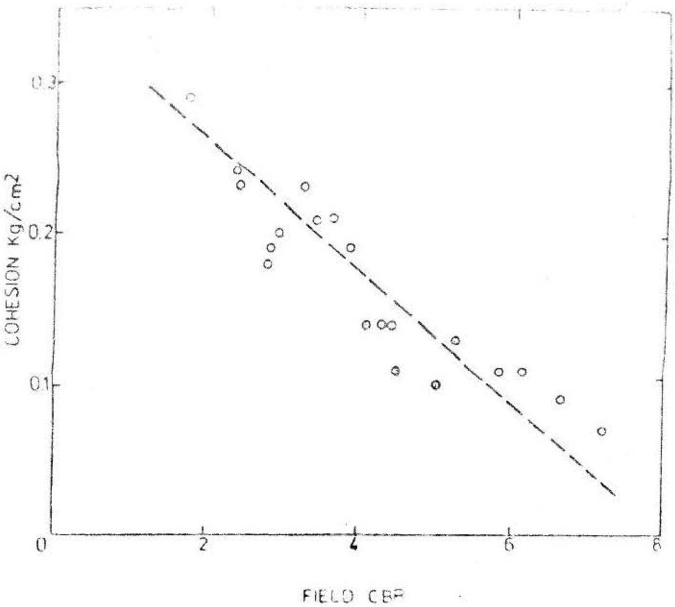

FIGURE 2 Variation of cohesion with field CBR

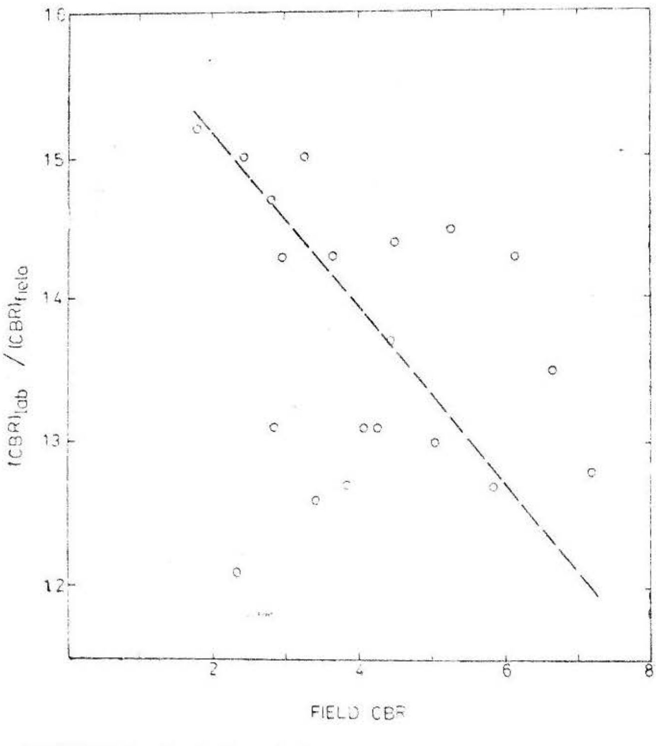

FIGURE 3 Variation of $(CBR)_{lab}/(CBR)_{field}$ with field CBR

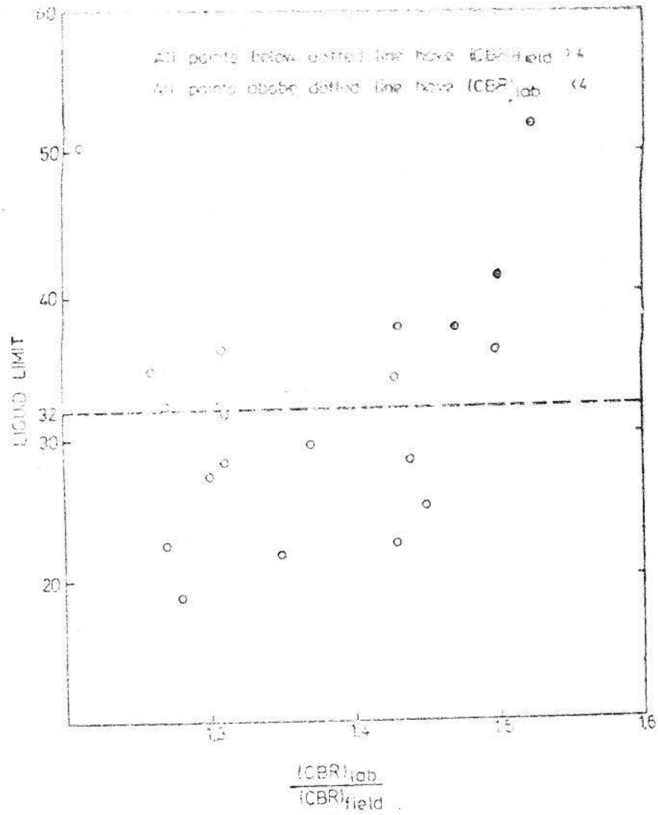

FIGURE 4 Variation of $(CBR)_{lab}/(CBR)_{field}$ with liquid limit

2. The variation of $\frac{(CBR)_{lab}}{(CBR)_{field}}$ versus field CBR is shown in Figure 3. Though there is considerable scatter there is a tendency for the ratio to be higher for low values of field CBR.

3. The ratio $\frac{(CBR)_{lab}}{(CBR)_{field}}$ is high for soils with high liquid limit. From the three tables given by author and his Figure 7, it may be concluded that the soils with liquid limit $>$ 32 per cent and 2 μ soil content of $>$ 24 per cent the CBR will always be less than 4. There are 10 such tests out of 20 (See Figures 4 and 5).

The writer wishes to emphasise again that the above observations as also given by the author in Figures 2 and 4 through 7 of the paper are valid for soils that are essentially similar to those that exist in the area investigated by the author. The writer feels that it may be possible to link up a factor which is a function of the index properties along with saturation moisture content and clay content with the CBR to obtain a unique relationship valid for the area.

Before ending the following errors appear to have been made in Figures 5 and 7.

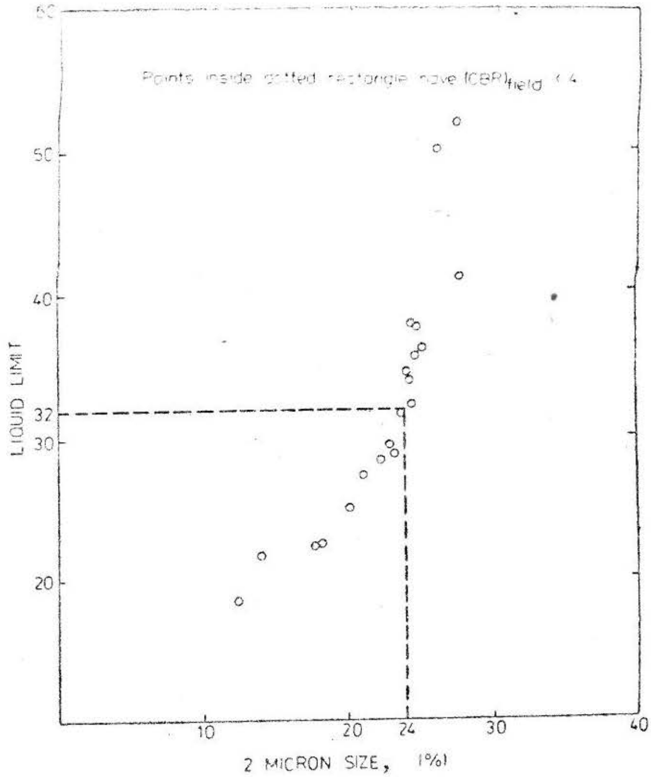

FIGURE 5 Variation of 2 μ Size partey with liquid limit

(*i*) In Figure 5 the abscissa should show CBR values of 1, 2, 3 etc. and not 10, 20, 30., etc.

(*ii*) In Figure 7 the points shown by (*o*) indicate the variation of clay content with CBR and those shown by (×) indicate the variation of liquid limit with CBR.

Reference

TOKHI, V.K. (1974). "Field performance of Soil-iime-cement stabilized base course stretches." *Civil Eugineering Coustruction and Public Works Journal*, Vol. 7, No. 1, pp. 31-37.

Author's Reply

The author wishes to thank Shri V.K. Tokhi for his keen interest in the above paper. The writer's comments are well taken and the author agrees with the three extra points brought out by additional analysis and interpretation of authors's data.

With regard to his other points the following may be noted :

(*i*) The loading frame used by author is a detachable one with the provision for the adjustments of width and height. The maximum dimensions of the loading frame are 140 cm × 80 cm in plan and height 130 cm. Figure 1 shows the plan of the part of the loading frame touching the ground. Thus the minimum distance from test point to the base channel is 40 cm. The ratio of this distance to the plunger dimension is as high as 8 indicating almost no effect of additional confinement due to the loading frame.

The arrangement presented by writer is also satisfactory and may be used if available. It may be mentioned here that the area wherein these tests were carried out lies in a dense forest and is accessible by jeep with efforts. Everytime it is necessary to dismantle the loading frame to enable to carry it, in the jeep and assemb at test location.

(*ii*) Actual data regarding the method of saturation was as follows. An initial head of 15 to 20 cm was given to the sample. After the head fell by about 10 cm or so more water was added to bring back the head to original value. This was necessary several times in some of the cases. Samples for moisture content were collected from just below the sample base and also moisture content was determined from samples taken from within the CBR mould after CBR was determined in the laboratory. All samples invariably showed full saturation. The author however appreciates the idea of estimating time required for saturating the field sample on the basis of estimated permeability so that planning of saturating the site can be done more rationally.

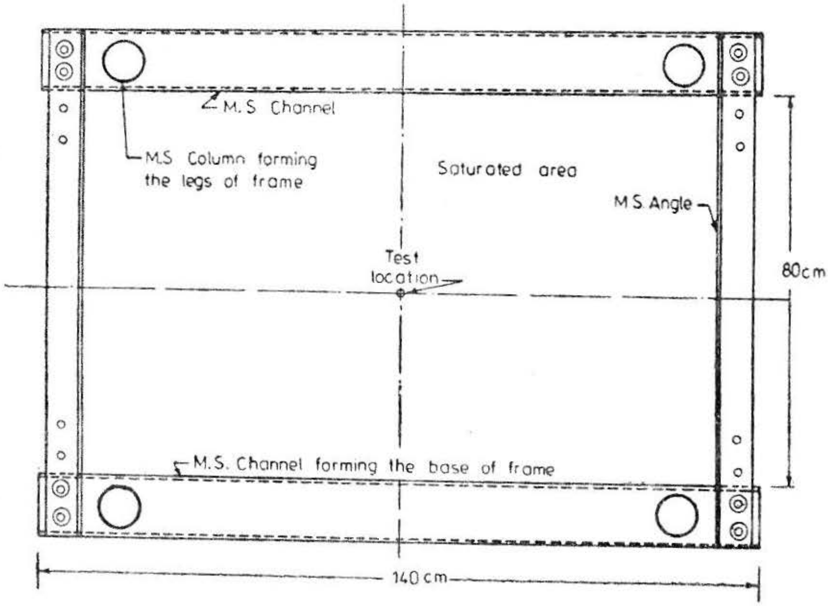

FIGURE 1 Plan of the part of the loading frame touching the ground

The author agrees with the writer's comments regarding the use of penetrometer resistance for estimating CBR value. It is, however, emphacised again that for actual pavement design greatest reliance must be placed on the field CBR values. Use of penetrometer readings is better limited to having approximate idea of relative CBR values at different locations. These readings can be of use in deciding locations where conducting field CBR test can be more meaningful and useful.