the samples of sand show the voids to be as follows (the tests were made with the material dry and shaken in such a way as to approximate the conditions of mixing and laying of the concrete):—

River sand	34·1%
Pit sand	33·7%

From this it is evident that any less than one part of cement to three parts of sand will provide insufficient

Fig. 2.—Block Cut from Pavement, Showing Segregation of Stone and Bridging Effect

cement to make a good mortar. A large percentage of the river gravel which I saw would not give any better proportion than one part cement to five parts sand, to three parts stone.

There are two methods of improving this condition:—

(*a*) By the addition of enough stone to make the proportions 1:3:5.

(*b*) By separating the gravel into sand and stone and remixing them in the proper proportions on the site of the work under construction.

Remedy (*a*) would require that almost every wagon load of material should be tested by sieving as it was laid down on the work. This would require at least the service of a competent man accustomed to such work. A great many practical considerations both from the contractor's and from the engineer's point of view, satisfy me that this would not be practicable on roadway construction in London.

Remedy (*b*) provides the safer means of surmounting the difficulty. In all kinds of government and civic concrete work the use of unscreened gravel has been as far as possible abandoned on account of the very great uncertainty of the proportions. Exceedingly few men are able to look at a sample of gravel and guess the proportions correctly, and as this generation has hung up, in a conspicuous place, the sign "Safety First," engineers generally have adopted this motto with regard to unscreened gravel.

The additional cost of separating the two materials and reproportioning will not add more than 25c. to 35c. per cubic yard to the price of the concrete, and that is a small price to pay for the safety and strength of the sub-base.

A sub-base of good concrete, with asphaltic surfacing replaced at periods of fifteen years, should last for at least seventy-five years. One other point should be mentioned in this connection and that is the increasing of the size of the loads. Motor trucks of ten-ton capacity are common, and trucks of twenty tons and over are assured for the future. It therefore becomes essential that the part of the pavement which is laid for permanency and which really carries the load should be of good material laid to get the greatest strength in the concrete.

The river sand, as separated, is clean, sharp and of good quality. It lacks the finer particles which tend to make a dense mortar. Plotting comparison of the river and pit sands with an ideal sand, it would be noted that on the finer sieve the curve of both sands comes considerably below the ideal sand. If the addition of fine sand could be accomplished without great cost, it would certainly improve the mortar.

The stone consists largely of limestone and dolomite pebbles, which are hard and clean. A small percentage (not more than 1% or 2%) of sandstone, granites and shales in a semi-decomposed state, are present in the gravel, but this percentage is not enough to affect seriously the strength of the concrete. The stone as used varies in size from ¼-inch to as large as five inches, and apparently the large stones are allowed to go into the concrete.

All the samples of concrete appear to have the required proportion of cement. It is impossible to judge the amount of cement used by inspecting the surface of the sub-base, because in a number of places rain has washed away the surface cement.

All samples of the concrete appear to be fairly well mixed. The strength of concrete depends to a large extent upon the time taken in mixing. Concrete which is mixed for ¼ of a minute has only 75% of the strength of concrete mixed two minutes. Very wet concrete mixed for ¼ of a minute has only 54% of the strength of well mixed concrete, therefore no concrete should be placed in roadways which has not been mixed one minute or more.

Fig. 3.—Fractured Surface of 6-in. Cube, Showing Effect of Segregating Coarse Aggregate

All the samples have very direct evidence of being mixed with too much water. The sub-base on Richmond Street, at the top of the grade and beyond to the end of roadway, shows this very clearly. There was also some evidence of an excess of water on Beaconsfield Avenue. Fig. No. 1 shows mortar bed of a stone taken from one