Discussion of Possible Designs Of Composite Pavements

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•THE purpose of the following is to discuss very briefly a few of the numerous possible designs of composite pavement.

Actually, in principle, a pavement of this type is by no means of recent development. For example, over a period of many years, pavements involving a portland cement concrete base overlaid with such materials as bituminous concrete, granite blocks, or bricks, have been constructed in many areas. Moreover, in recent years, many deteriorated PCC pavements have, in effect, been converted into composite pavements by the application of a layer of bituminous resurfacing material.

A typical design that has been used extensively for street construction in many cities, and even on some rural highways, is shown in Figure 1. This design involves a bituminous concrete surfacing on a plain concrete base, which is in turn supported on a layer of subbase. The probabilities are that most of the pavements of this type which are in service on city streets were not constructed on subbase. But despite this omission, practically all of these pavements have given a very good account of themselves, even under very heavy traffic.

In almost all cases, the plain concrete base has been constructed without joints of any kind, other than plain butt joints between each day's work. In this type of construction, the base sooner or later cracks transversely at erratic intervals, and thus becomes divided into a series of slabs. During cold weather there is a contraction of

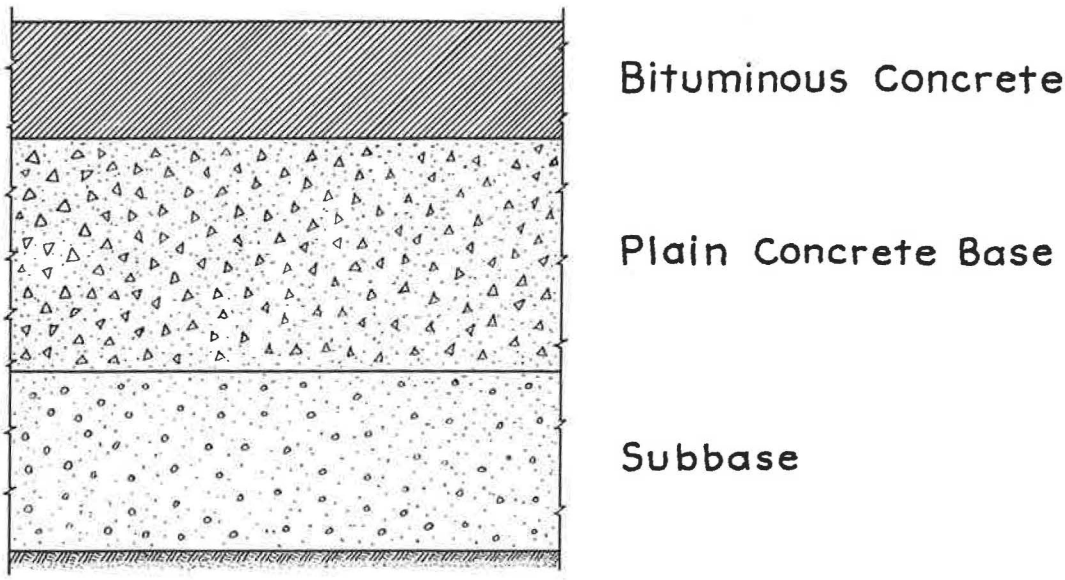

Figure 1.

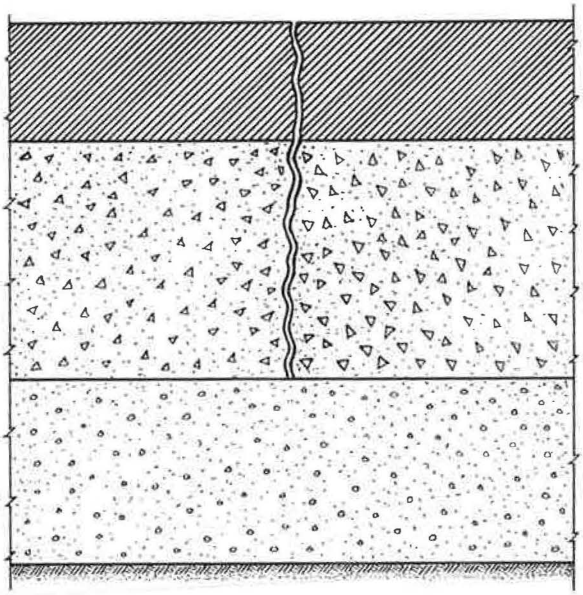

Figure 2.

the slabs, and a corresponding opening of the cracks. This, in turn, results in the development of so-called reflection cracks in the bituminous surfacing—these cracks being directly above the cracks in the base. A typical reflection crack is shown in Figure 2.

The reflection crack is coincident with the crack in the base, and of essentially the same width. These cracks are due mainly to the development of excessive tension in the bituminous surfacing, that is, immediately above the cracks in the base, with the result that the surfacing is pulled apart at these cracks. As is well known, the same sort of thing inevitably happens in connection with resurfaced concrete pavements, in which reflection cracking occurs over the joints and also over any cracks which undergo appreciable changes in width.

Reflection cracks are objectionable for several reasons, some of which are as follows:

1. They tend to undergo a progressive increase in width.
2. They permit the leakage of surface water to the subgrade. This water, especially if it contains de-icing agents, can also have a damaging effect on the base.
3. Inevitably, there is serious raveling and disintegration of the bituminous surfacing adjacent to the cracks. This, in fact, is their main objection.

For these reasons, one of the most important problems in connection with a pavement of this type is that of preventing the development of reflection cracks. Various designs which seem to offer promise of accomplishing this objective, at least to a very great extent follow.

Figure 3 shows a rather elaborate design which involves:

1. A surfacing of bituminous concrete containing reinforced steel (the steel may consist of either welded wire fabric or expanded metal).
2. A plain concrete base with contraction joints at close intervals and an underlying layer of subbase.

The function of the reinforcing steel, in effect, is to increase the tensile strength of the bituminous surfacing, to the extent that it will not be pulled apart at the contraction joints in the base.

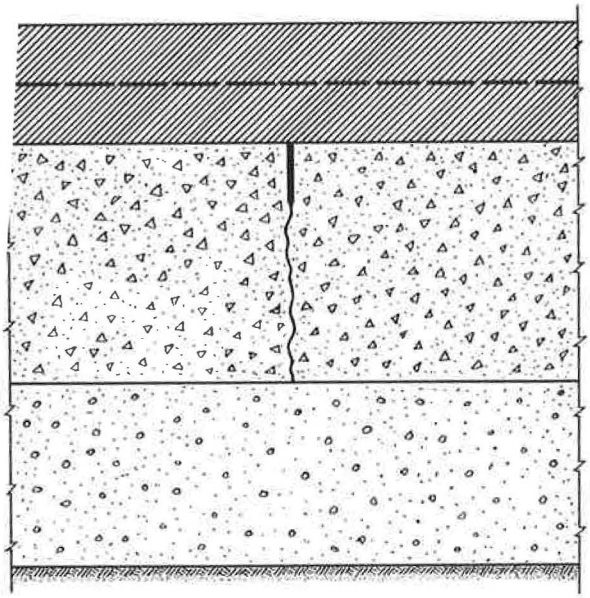

Figure 3. Typical reflection crack.

The purpose of installing the contraction joints at close intervals is mainly to restrict the amount of joint opening, and thus to avoid a situation wherein the reinforcing steel is called upon to do more than it is capable of doing.

Over a period of years, several test sections of pavement conforming essentially with this design have been constructed in New Jersey, and on the basis of the very satisfactory performance of these sections, it is now planned to utilize this design in connection with several miles of pavement soon to be constructed on an Interstate route.

Figure 4 shows a design involving a bituminous surfacing on either a lean concrete base or a cement-treated base. This design is based on the premise that, if the base has a low cement content, the cracks in the base may, for various reasons, be of such limited width as not to induce reflection cracks in the surfacing. Undoubtedly a number of pavements of essentially this design have already been constructed in various parts of the country.

Experience has indicated that relatively thick bituminous overlays are beneficial from the standpoint of at least minimizing the seriousness of reflection cracking. The design shown in Figure 5 has been developed with this in mind. This design involves a bituminous overlay of substantial thickness, in which the major portion of the overlay, for reasons of economy, consists of bituminous-stabilized base. Incidentally, it seems quite possible that one of the reasons why a thick overlay is beneficial is that it tends to reduce the over-all seasonal changes in temperature of the base, and thus to reduce the changes in width of the cracks in the base.

The design shown in Figure 6 appears to have considerable promise. It includes an intermediate layer of untreated granular material between the bituminous surfacing and the base. The purpose of this intermediate layer is, of course, to so separate the surfacing from the base that the cracks in the base will not induce reflection cracks in the surfacing. It appears, however, that there may be some risk involved in this design, especially if the surfacing is too thin, or if the materials in the intermediate layer are not of first-class quality. On the other hand, outstandingly satisfactory performance has been reported in connection with certain pavements of this design, notably in one of the Southwestern States.

To avoid such risks as may exist in connection with a relatively thin surfacing, Figure 7 goes a step farther and introduces a layer of bituminous-stabilized base be-

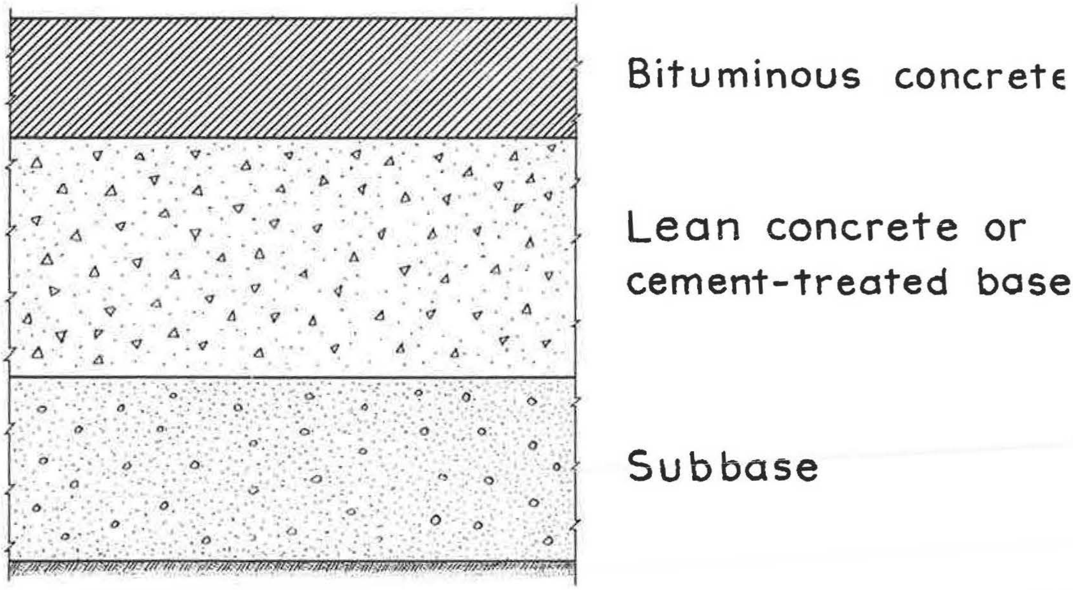

Figure 4.

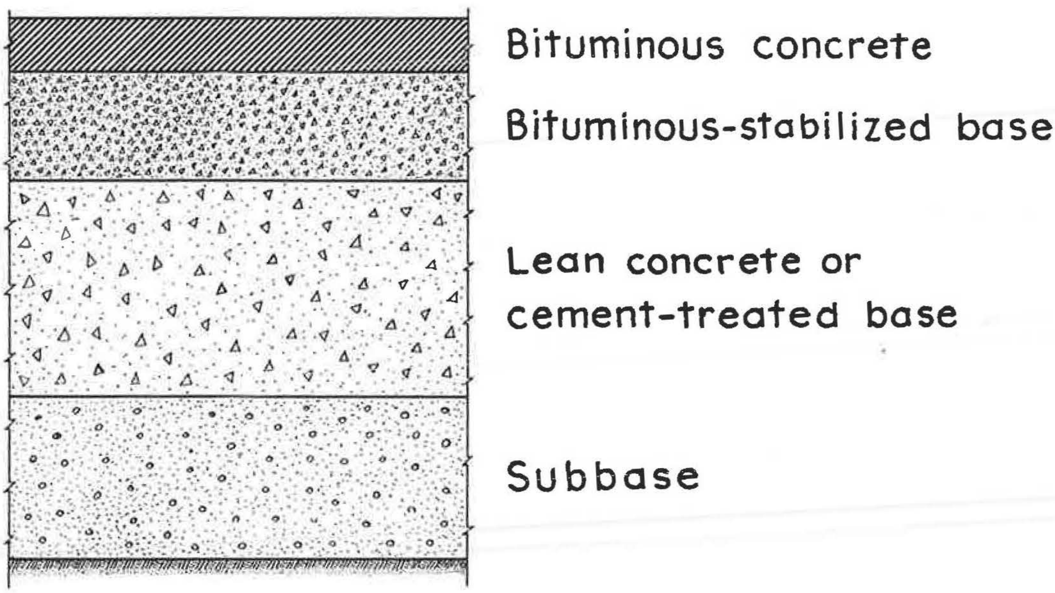

Figure 5.

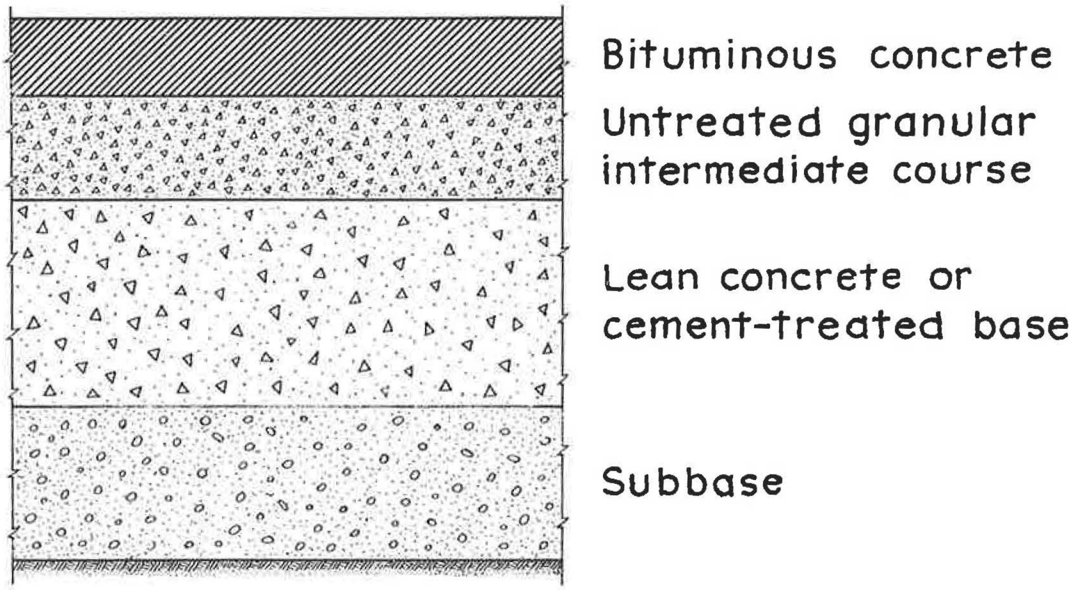

Figure 6.

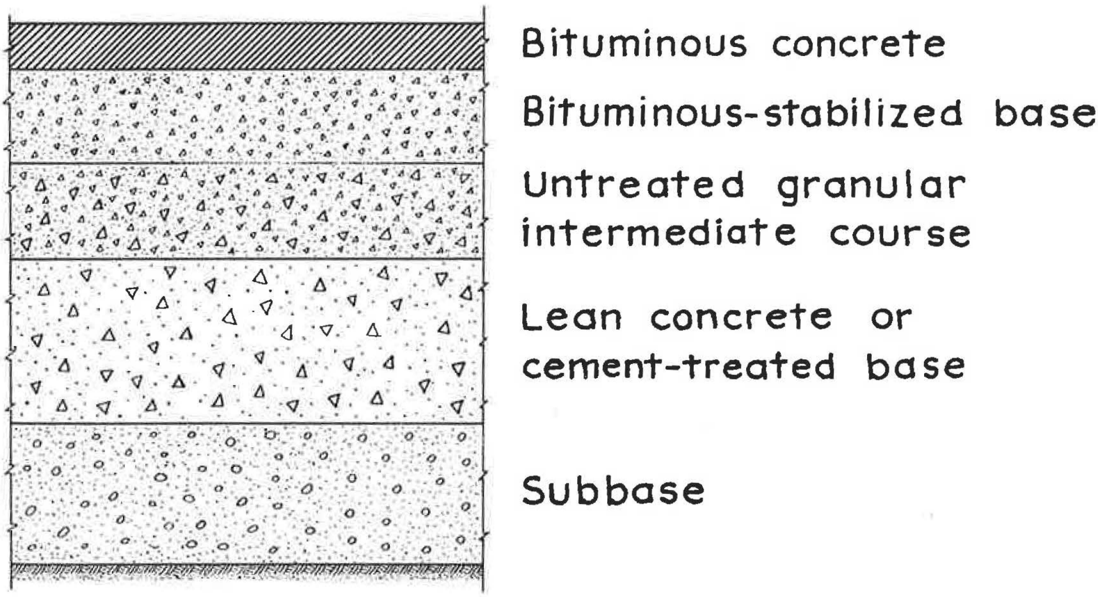

Figure 7.

tween the surfacing and the intermediate untreated granular layer. Whether or not this precaution is really necessary is something which is still to be determined. At any rate, because this design appears to offer considerable promise, it is intended to construct a test section in New Jersey on one of the major trucking routes.

Figure 8 shows a design in which the objective is to prevent reflection cracking by using a type of concrete base in which the opening of the cracks in the base is so slight as to have no adverse effect on the surfacing. As related to this type of base, those who are familiar with continuously-reinforced concrete pavements know certain basic things about them:

1. They contain a considerably greater amount of longitudinal reinforcing steel than installed in conventional concrete pavements.
2. Initially, the steel induces the occurrence of transverse cracks at very close intervals, and then subsequently prevents these cracks from opening to any significant extent.

A continuously-reinforced concrete pavement should, therefore, constitute an excellent base for a bituminous surfacing. Unfortunately, however, owing to its relatively high cost, this type of base would perhaps be warranted only under exceptional circumstances, such as in connection with a very heavily traveled pavement in an urban area, where its cost might very well be fully justified.

But be that as it may, the indications are that the required amount of reinforcing steel is more or less directly proportional to the tensile strength of the concrete. Consequently, if a lean concrete base were to be constructed having a tensile strength substantially lower than that of normal concrete, it would require proportionately less steel. Therefore, as a result of the reduction in the amount of cement and steel, it may be entirely possible to construct a composite pavement of this design at a cost which is very little if any higher than that of a high-grade pavement of conventional design, and the performance of which could prove to be notably outstanding.

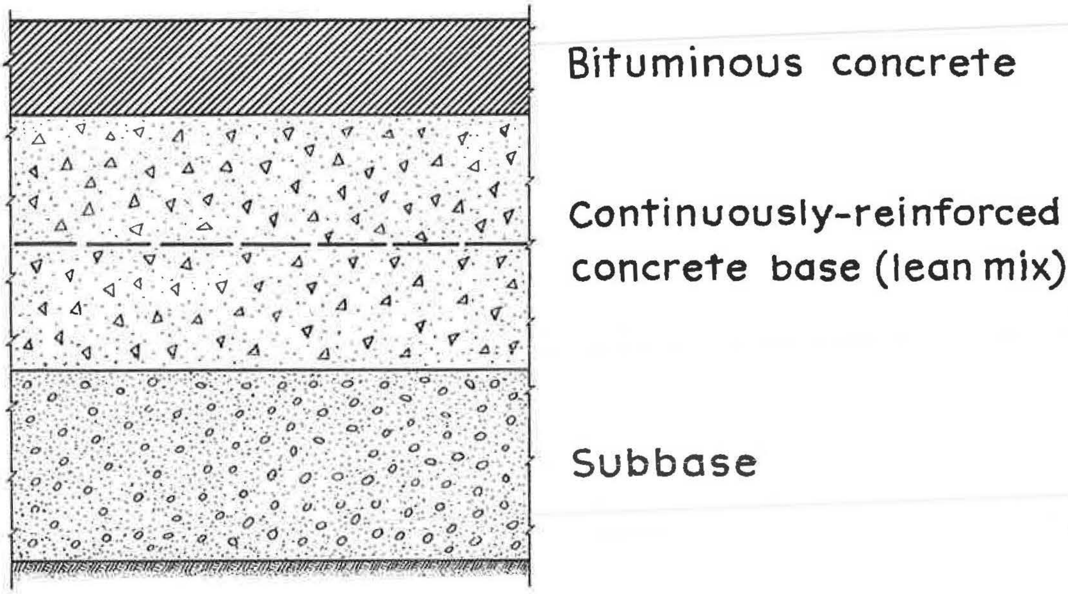

Figure 8.