

# Composite Pavement Design

by

James H. Havens  
Director of Research  
Kentucky Department of Highways  
Chairman, Committee DB-3

Presented in Session 44, 45th Annual Meeting  
Highway Research Board  
Washington, D. C.

January, 1966

There is an aura of superiority attached to the work "composite"-- that is to say, the composite of anything is expected to be superior to its distinct elements of parts. It will suffice here to define a composite pavement as being compounded of "rigid" and "flexible" parts or layers. In reality, we mean layers of portland cement concrete and bituminous concrete--each of which is admirably sufficient in itself or may be so down-graded to satisfy lesser desires. Even so, we seem always to be discontent with the status quo. We are all somewhat opinionated on matters of pavement design and types of pavements; in the same way, some way cherish hope that some lingering dilemmas may dissolve in the combination and "composite action" of the two--and also that the one will enhance the other. Certainly there is evidence that bituminous overlays are worthy recourses when the condition of a concrete pavement becomes unsatisfactory; however, there is no intent here to imply advocacy of any extraordinary pavement structure--except for study and experimental purposes.

Our assignment here is to assess the present-state-of-the art of composite pavement design and construction and, further, to assess performance. It is safe to say, at the outset, that criteria of design cannot be any more refined or sophisticated than "flexible" or "rigid" pavement criteria--perhaps we will find ultimately that the same rational theories suffice for "flexible" and "rigid" and for "composite" pavements.

Let us magnify the concepts of "rational theory" and "criteria of design" somewhat:

1. If we measure some abstract, physical parameter of a pavement system, such as deflection under a range of loads, and thus equate deflection to load, we have an equilibrium equation, but it is empirical. Then, if by analysis of performance, statistical, we are able to assign limits to deflection, we have an equation of

## Composite Pavement Design -- James H. Havens

failure--which has also been empirically derived. By combining these equations--that is, equating the equilibrium conditions to the failure condition, we have the basic elements of an empirical, design criterion. Instead of deflection, we might have used thickness--on the assumption that deflection is proportional to thickness.

2. If, by elastic or visco-elastic theory, we are able to assign discrete moduli to the pavement components and thus to compute stresses and strains under loads, we have an equilibrium equation based on theory. This theory tells us only the magnitude of stresses and strains; it tells us nothing about their limits or strengths of the materials--these have to be determined by test. Here again, the equilibrium condition must be equated to the failure condition. The observed mode of failure in full-scale or model-scale tests offers substantiating evidence and proof that the theory is sufficient--this is the real test of the theory.

In this brief report, we cannot hope to present a thorough, exhaustive treatise--because there are too many avenues to explore. Until now, most pavement theories and theories of layered systems have been concerned principally with the condition wherein pavement layers increase in stiffness toward the top course or with a single layer such as a concrete slab on a soil foundation. In the concept of composite pavements, we must consider the case where a weaker layer is superimposed over a stronger one and also the case of composite slab action--that is, where the pavement, although made up of layers, comprises a unit structure: as a laminated sandwich or a filled-truss-type slab.

In a very simple way we may illustrate a design concept for bituminous overlays as shown in Figure 1. It is assumed that the bituminous overlay spreads the load over a larger area onto the underlying concrete. The area of the spread depends on thickness of the overlay and its resistance to shear. The concrete base might be designed according to existing criteria--giving credit to the load-spread in the overlay. This might be viewed as a planned deficiency in the thickness of concrete--which is to be compensated by the overlay, in some equivalent relationship or proportion. In the same way, the thickness of overlay needed on an existing concrete pavement to strengthen it for heavier service may be determined.

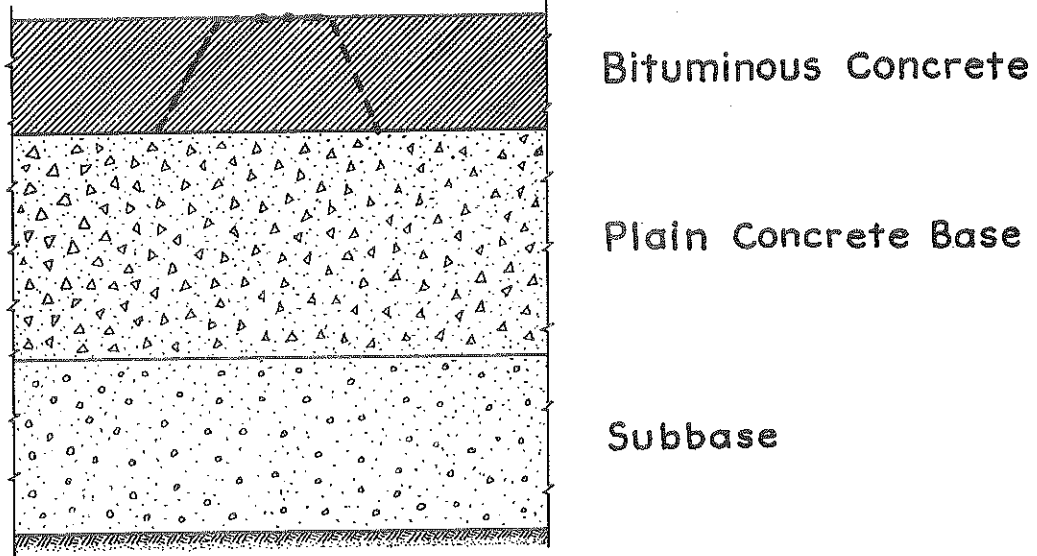


Fig. 1

Other drawings will illustrate an array of options in cross-sections of composite pavements.

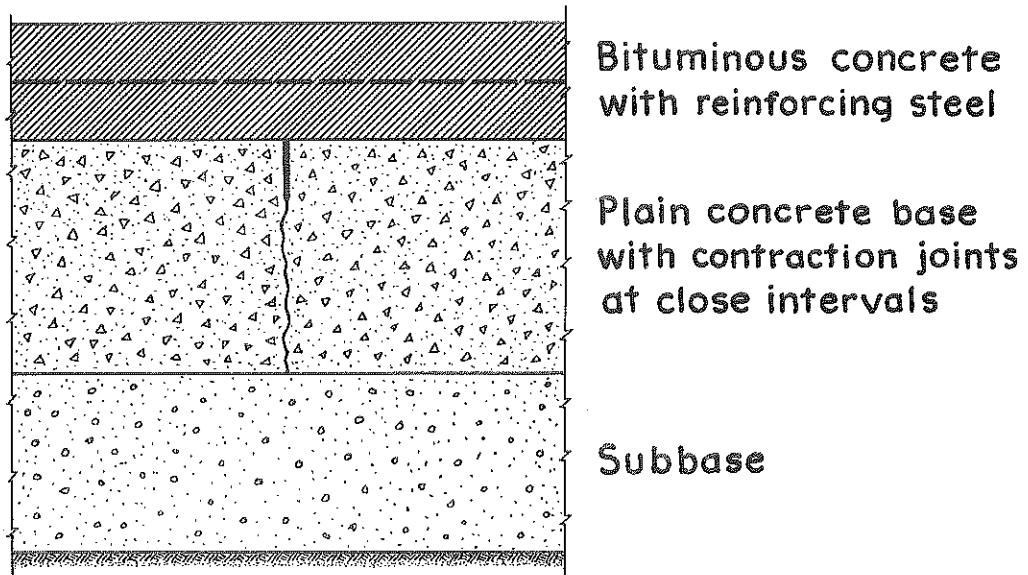


Fig. 2

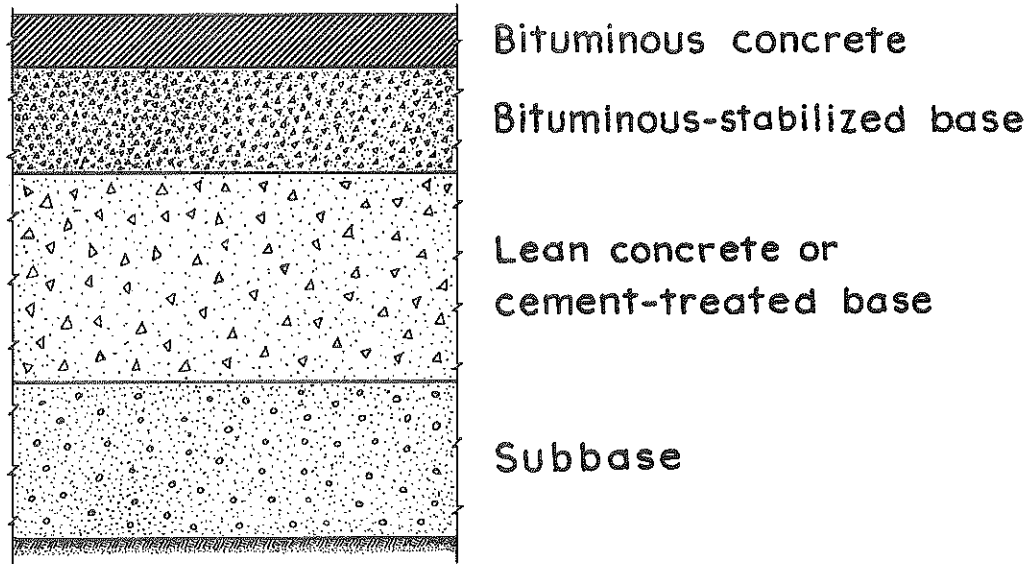


Fig. 3

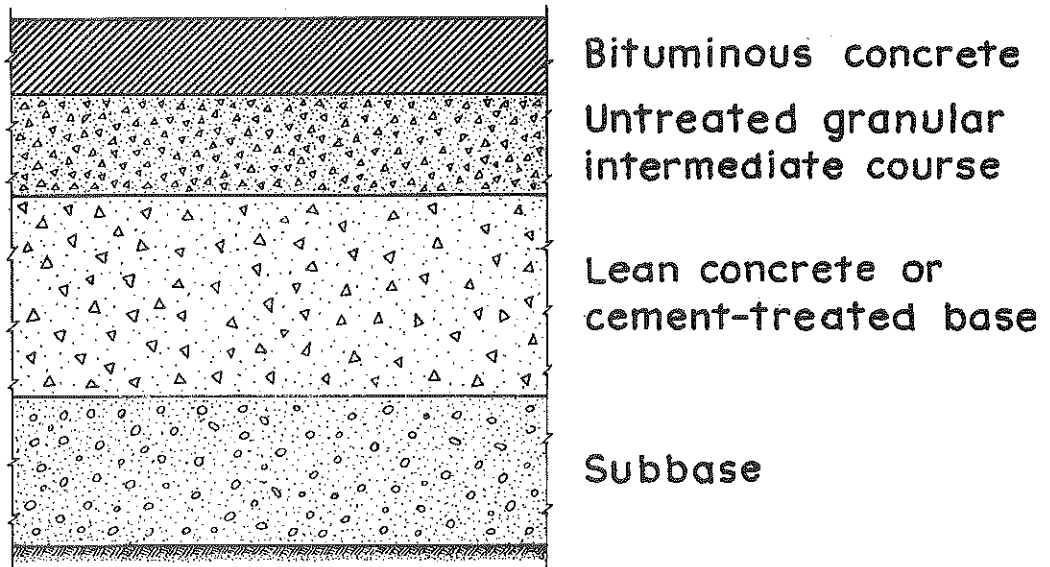


Fig. 4

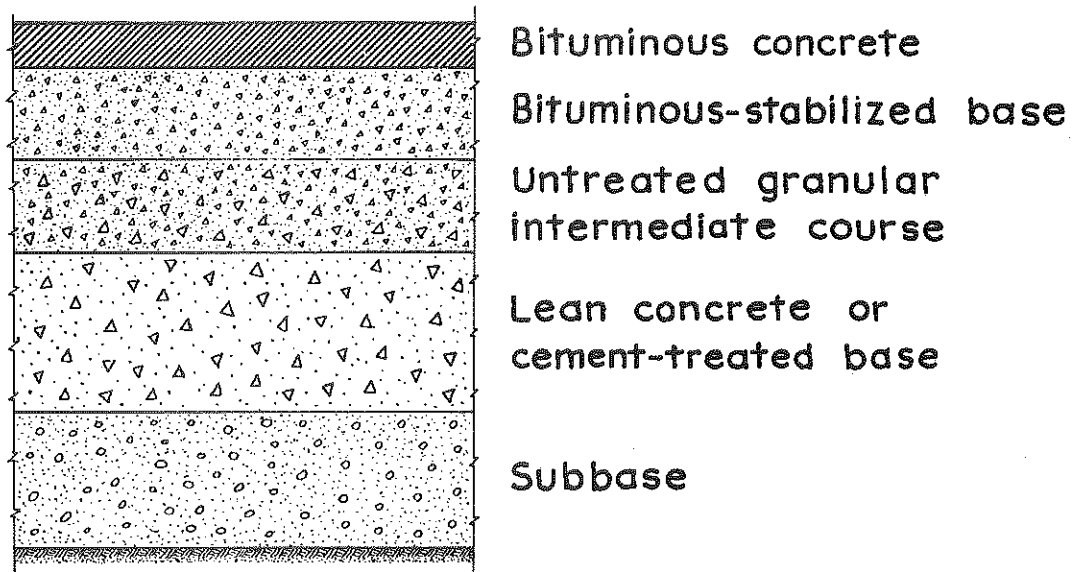


Fig. 5

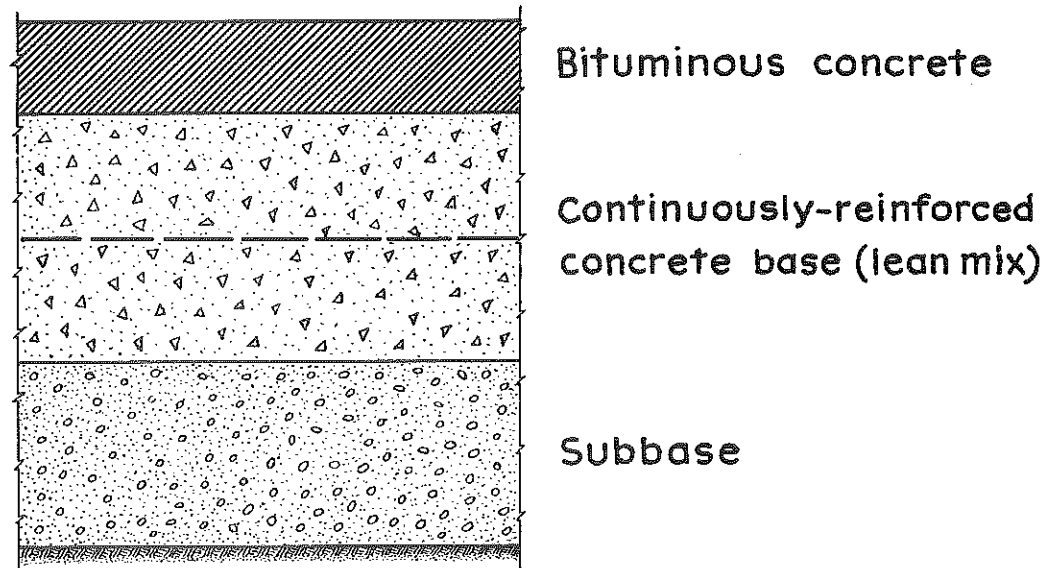


Fig. 6

## Composite Pavement Design -- James H. Havens

Other options--not illustrated--are conceivable and may be equally practical. For instance, concrete may be laid over a bituminous base. Then, we can visualize bituminous concrete sandwiched between relatively thin layers of continuously reinforced, and even prestressed, concrete --and perhaps connecting steel between them. Perhaps we should emphasize again that sandwiched slabs which react to load as a single structural unit may not rightly be considered to be composite pavements-- in it strictest connotation.

We may list some advantages claimed for composite pavements-- especially those consisting of overlaid concrete:

1. Smoother surface--attributed to firm foundation; tends to minimize rutting.
2. Reduction of thermal stresses and warping in concrete layer--attributed to buried condition and insulation above.
3. Reduction in freeze-thaw damage to concrete.
4. Amenable to surface renewal.
5. Possible use with slip-form paving.

Some disadvantages of bituminous overlays are:

1. Reflection cracking
2. Possible additional cost when incorporated in new construction.

For further discussions and details of existing design criteria, refer to Highway Research Record No. 37, 1963, and to Highway Research Correlation Service Circular No. 473, July, 1962.