MINERAL AGGREGATES FOR BITUMINOUS PAVEMENTS

By Wallace L. Caldwell

(Continued from last week's issue)

FILLER, which is finely ground mineral dust, is ordinarily used in all types of mixed method pavement, except bituminous concrete pavement with a mineral aggregate of crusher run stone or pit run gravel. Its use produces a dense pavement, reduces liability of displacement, enables a softer asphalt cement to be used, and causes the surface to be less susceptible to damage from water.

An ideal filler should be finely ground, not merely so that a considerable percentage will pass a 200-mesh sieve, but so that at least 60% will be a true dust or impalpable powder, as determined by the elutriation test. It is this powder which really serves as the filler and which produces the results required of a filler. The remaining portion of the filler simply serves as sand.

The grains of the filler should have a surface which will absorb a heavy film of bitumen. Very hard dense grains do not absorb a sufficiently thick film of bitumen to permit such grains to fulfil all the functions of a filler even though the material be ground to the requisite fineness.

Portland Cement Best Filler

The filler should be so constituted, chemically, that it will have no harmful action upon the bitumen and so that water will not in any way react with the material. The material should not be light and fluffy but should have a weight of at least 90 lbs. per cu. ft. Lighter materials are readily blown away when being placed in the mixer, with the result that the mixture has a variable and always low percentage of filler. Closed mixers eliminate this difficulty, but are found on only a few plants. Light-weight fillers, when used in sheet asphalt, often produce a fluffy mixture, which will not rake well and which does not take compression as it should. Among the fillers commonly used are portland cement, ground limestone, slag dust and ground silica. Nearly every kind of pulverized mineral has been used at one time or another. Practice has clearly shown portland cement to be the most successful filler, and limestone dust to be relatively second in value. Portland cement seems to produce a somewhat denser mixture than any other filler, and when heavy traffic must be provided for, its use is advisable. The reason for this is somewhat obscure, but principally is due to the slightly porous nature of the portland cement grains. This property results in each grain absorbing a certain amount of bitumen, and permits the formation, around the grains, of a tenaciously held and rather thick film of bitumen.

Limestone dust has been used with entire satisfaction. Slag dust has not been extensively used but has given good results wherever used. It would not be advisable to use the dust from an acid slag, because of the hard, glassy nature of the material, but no criticism can be made of the dust from a basic slag. Silica dust from a number of different sources has been widely used. No serious trouble has resulted from its use, but in general it has not given as good satisfaction as certain other materials.

Good filler is scarce to-day, the production having fallen below the demand. Many products which cannot be classed as a dust in any respect are being offered. Products having 50% of material passing the 200-mesh sieve but containing very little actual dust as determined by the elutriation test, are not uncommon. In several cases agricultural limestone containing 20 or 25% of 200-mesh material, with coarse grains as large as ¼ in., has been used and has been called filler. Ground stone such as this contains no true dust and simply serves as a source of fine and intermediate aggregate, with the result that the mixture contains no filler.

Stone Should Be Cubical

Limestone, dolomite, trap rock and granite are the rocks most commonly used in bituminous construction, although sandstone, gneiss and certain other rocks have been used to a limited extent. The rock should be sufficiently hard to resist the abrasive action of traffic and tough enough to withstand the impact of iron-shod hoofs and of vehicles. It should be clean and free from clay. If the rock contains fine screenings it should be freshly crushed, since the dust tends to collect on the surface of the larger pieces and, if once wet, forms a scum on the surface, which is dried and baked when the stone is passed through the heating drums. This film effectually prevents the adherence of the bitumen to the surface of the rock.

The individual pieces should be as nearly cubical as possible, since stone which crushes in slabs or slivers produces a mixture which cannot be compressed to as great a density as if a stone of cubical fracture is used.

Slabby pieces of stone are more easily fractured by traffic and thus are likely to cause the pavement to ravel. A stone having a structure and surface which will permit of absorption of a certain amount of bitumen is to be preferred to a stone with a hard, dense surface which will permit of no impregnation.

Physical Tests of Stone

Fortunately, satisfactory physical tests have been devised for rock. The U.S. Bureau of Public Roads and others have made thorough investigations of the methods and interpretations of these tests. Hubbard and Jackson, in Bulletin 370, U.S. Department of Agriculture, have tabulated a great amount of data and have given valuable interpretation of the results of their tests. Too few specifications call for these tests.

It has been the writer's experience that for city pavements, subjected to ordinary traffic, no rock having a French coefficient of wear of less than 8, or a toughness of less than 8, should be used. Under very light, residential traffic it is sometimes permissible to permit the use of a rock with a toughness of 7 and French coefficient of 6, but under no circumstances should an aggregate of lower value be used. For heavy city traffic, the requirements should be increased to a French coefficient of wear of at least 10 and a toughness of between 10 and 14, depending upon the density and nature of the traffic and the size and character of the aggregate. Binder stone should have a toughness of at least 7. Of the two tests, toughness is undoubtedly of the greater value when considering the quality of rock for a bituminous pavement.

The grading of the crushed stone is of vital importance, and in bitulithic and asphaltic concrete pavements, it is given careful attention. The density of any coarse aggregate mixture is dependent upon the proper grading of the stone. In some cases, stone as received from the quarry may be of the proper grading, but often a combination of crushed stone of different sizes must be used. In bitulithic pavement the stone is screened into various sizes, each size stored in a separate bin and re-combined in the proportion desired by weighing a definite amount from each bin.

Trailings From Ore Mines

Since their use is rather widespread, it will be well to mention chats or trailings from certain ore mines. The two materials of this class most commonly used, at least in the east, are from the zinc mines of eastern Tennessee and the Joplin, Mo., district.

The Tennessee chats are a limestone, averaging 97% calcium carbonate, are very hard and tough, and have an unusually high specific gravity and a decidedly cubical fracture. The surface of the pieces of rock is perfectly clean, washing being a part of the ore-dressing process. Most excellent results have been secured from this material.

The Joplin chats are a flint, are hard and tough, have a good cubical fracture, and are clean, but have a very smooth surface which does not hold a thick film of bitumen. However, excellent results have been obtained in many pavements with these chats. In the process of manufacture both materials are so crushed that they will pass a 2-mesh sieve. They are, therefore, used almost entirely in asphaltic concrete pavements of the Topeka type.

Crushed blast furnace slag has in the past been used to