Preparing the Subgrade

A PROPERLY constructed subgrade is the first important factor in the building of a quality concrete pavement. There are two cardinal requisites—lead the water away from the subgrade and be sure that the subgrade supports the pavement uniformly. Subgrades are composed not merely of earth, but of various types of soils whose differing properties require treatment suited by their needs. In the main, these soils may be classified as clay, sand or loam. It has been shown that water will travel by capillary attraction through any soil, it spread, being governed by the fineness of the soil particles and the direction of the movement. The finer the particles, the greater the number of voids and the greater the capillarity. Hence a finer soil will contain more water, will draw water from a greater distance and will hold that water more tenaciously.

Clay is a very finely divided soil, brittle when dry but plastic and tenacious when wet. Because it will absorb a large amount of water, it will swell, and when saturated clay freezes, the expansion may cause damage to the pavement. Clay is an exceedingly difficult soil to drain. It must, therefore, be protected as much as possible from the presence of water. Cut underbrush so that air circulates freely and no part of the subgrade from ditch to ditch be in perpetual shade. Ditches must be carefully constructed so that water will not stand in them. They should be well away from the road and of large capacity. The slope from the pavement edge to the highwater mark in the ditch should be sufficient to allow free and rapid drainage. Care must be taken that clay shoulders slope away from the edge of the pavement. Big holes and springy places in the subgrade must be well drained either by tile lines or by trenches filled with stone. When springy spots develop under the roller, the best method of correction is to remove the soggy material and refill with dry material, hand tamped in 6-inch layers. Do not roll the spot again.

Sand is made up of rock particles. When confined, sand is an excellent material on which to place a rigid pavement, but care must be taken to prevent the sand from flowing out from under the pavement. As water sinks into sand quickly, only shallow ditches are necessary. Sand embankments should have extra shoulders and the side slopes should be as flat as possible. It is useless to try to roll a sand subgrade.

Loam is a mixture of sand, clay and organic matter. It occurs in all variations between clay and sand. For the heavier loams, the precautions used for clay subgrades apply, but usually loam subgrades require no special treatment except that low and springy sections must be drained.

The important point is that subgrades of all types must support the pavement evenly. There must be hard ridges or points on which the pavement would rest. The path of an old wheelway, packed hard by many vehicles may be adjacent to soil as soft as any in the field. The entire roadway should be plowed to a depth of at least 6 inches, then harrowed and compacted evenly.

Sampling Aggregates

THE requirements of both fine and coarse aggregate are usually definitely established by the specifications and, in a general way, laboratory tests made before the job is started, determine the suitability of materials taken from available sources of supply. But these precautions do not relieve the inspector of responsibility in the matter of aggregates. It is his duty to see that the materials as delivered on the job meet the intent of the specifications. He must control the quality of the materials throughout the progress of the job.

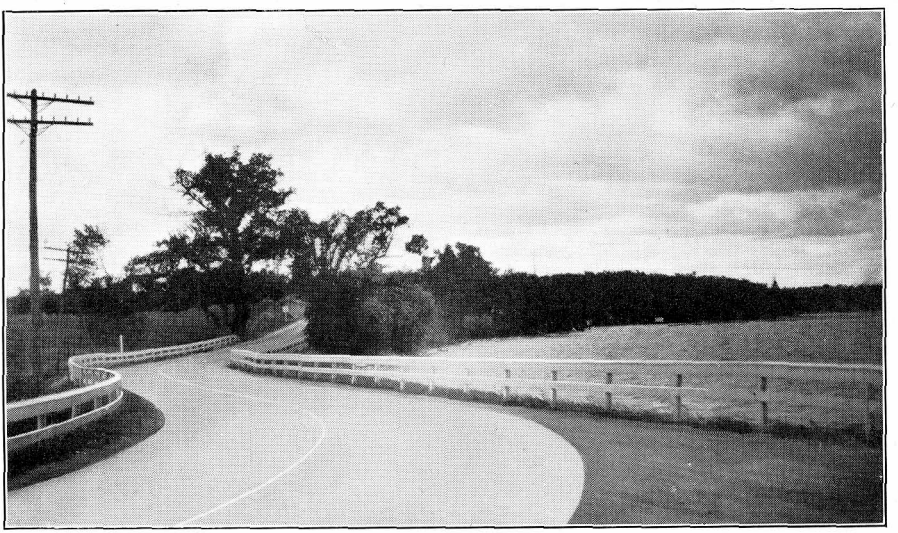
To do this, more than a superficial inspection is needed. It is not enough merely to take a handful of sand or pebbles, rub it between your fingers and then pass judgment. Certain easily performed field tests will provide a fairly reliable standard of comparison, and, if the quality of the material is still in doubt, a representative sample should be sent to the laboratory.

It is important that the fine aggregate be well graded in size. An excess of fine material passing the 100-mesh sieve gives rise to difficulties. More mixing water is required; the strength of the resulting concrete is reduced and the surface texture of the pavement is affected. Five per cent should be the limit for material passing the 100-mesh sieve. Frequent sieve analysis are necessary to control this important requirement in fine aggregate selection.

Field tests of material ought to be supplemented by laboratory tests, especially when the suitability of the material is in doubt and when new sources of supply are tapped. When sampling materials for laboratory tests, care must be taken to obtain a representative sample. The size of the sample will, of course, depend on the nature of the material and on the scope of the tests to be made. Generally a sample of fine aggregate should contain not less than 50 pounds and a sample of coarse aggregate not less than 100 pounds. The sample sent to the laboratory should be taken from a selected sample four times as great and reduced by quartering, i. e., by thoroughly mixing, divide into quarters and eliminating diagonal quarters. This operation is repeated until the sample is reduced to one quarter its original size.

In sampling the open face of a pit, the best method is to scoop vertical troughs at equal intervals along the face, placing the material taken from each trough on a canvas and quartering it down to the desired size.

When samples are taken from loaded cars it is necessary to do a considerable amount of digging to obtain a sample representative of the material in the car. A good method is to dig a hole two or three feet deep at several points in the car and, starting at the bottom of each hole, drag the point of the shovel up the side. The samples thus taken from each hole should then be mixed and the composite sample quartered down to the desired size.



Skirting the Shores of Orchard Lake

WATER SUPPLY

WATER in sufficient quantities to meet the needs of the contractor is an important item in the construction of quality pavements. While as little water as possible should be used for the mix, a great deal of it is needed for curing. That this supply may always be available, it is advisable for the inspector to satisfy himself that the pumping equipment and pipe line is adequate for all requirements.

Water is needed for three primary purposes: wetting the subgrade, mixing the concrete and curing the pavement. The quantity required naturally varies with the progress made, weather conditions and other factors to each job. In general, a supply of from 12,000 to 15,000 gallons per day for each 100 lineal feet of 18-foot pavement constructed will be sufficient. This is assuming an equivalent depth of about one inch for curing and wetting the subgrade and a maximum amount of mixing water of 8 gallons for each bag of cement used. The total quantity required for each 100 lineal feet of 18-foot pavement will, therefore, be approximately 300 gallons for wetting subgrade, 2,200 gallons for mixture, and 10,000 gallons for curing (assuming a specified curing period of 14 days). For each additional 100 feet of progress an equal amount will be needed.

The rate at which the supply is to be delivered depends upon the speed with which the pavement is being placed. Few contractors require more than 50 gallons per minute and this amount is usually ample for the average job.

The size and length of the pipe line is as much a factor in determining

the rate at which water will be delivered as is the pumping equipment. A table of friction heads for various size pipes will show, for example, that a new 2-inch pipe delivering 50 gallons per minute has a friction head of 5.6 feet for each 100 feet of length, while a 2½-inch pipe, delivering the same amount of water has a friction head of only 1.86 feet per 100 feet of length. For old, rusted pipe, from 25 to 50 per cent should be added to the friction loss and allowance must be made for fittings and angles.

Generally, a pipe line having a friction head of more than 5 feet per 100 feet of length will be uneconomical and a larger pipe should be substituted. A long pipe line with a high friction head imposes a heavy duty on the pumps and it is frequently necessary to install a booster pump along the line when the available line is of small diameter.

By making a study of this important subject of water for his job, the inspector can often render valuable assistance to the contractor and guard against delays and unpleasantness due to lack of water for curing.

At the Mixer

MIXING the concrete and placing it on the subgrade is, perhaps, the most important item in the construction of a concrete pavement and is the activity which requires the most careful attention of the inspector. There are numberless items to watch. Some are listed here as follows:

The subgrade must be low enough to give the full thickness of the slab at all points.

All ruts made by the mixer or the trucks must be smoothed out.

Earth used to bring low spots to grade must be tamped carefully until it is as firm as other parts of the subgrade.

Forms must be in good alignment and set at the proper grade with enough bearing to hold them rigidly while the concrete is being placed and finished. It is well to watch the forms behind the mixer, and, if even the slightest displacement is observed, to insist that they be set more securely in the future.

It is better to have the subgrade thoroughly wet a day ahead, rather than just before placing concrete. If sprinkling is done immediately ahead of the mixer, care must be taken that the stream of water does not throw earth on the edge of the concrete. Even a slight covering of dirt or dust will cause a plane of weakness which will result in a ragged crack.

When the batch is placed on the subgrade, shovelers must be careful not to get earth mixed with the concrete.

Workmen must not walk on the soft concrete after it has been struck off. Boot tracks are usually filled with "soup" which will shrink when setting and cause a soft spot which will readily develop a hole.

The surface of the concrete must be watched constantly for high and

low places. Low spots are often filled with water and are, therefore, hard to detect.

It is important that concrete which is shovelled against the forms is not deficient in mortar to prevent the edges from being pitted with voids. If workmen will work the concrete with the back of the shovel toward the forms, it will help in getting mortar at the edge of the slab.

The steel must be covered sufficiently.

If the mixer is stopped for a period too short to require a construction joint, the old and new concrete should be worked together when the mixer is started again.

Too much mixing water reduces the strength of the concrete. It is important that slump tests be made often enough to insure a uniform consistency, dry enough to meet the requirements of the specifications.

The mixing time must be adhered to rigidly.

Constant vigilance is the price of a good job and it is at the mixer that the inspector has the best opportunity to demonstrate his worth. No detail is unimportant for it is the successful accomplishment of each operation that results in a creditable pavement.

Surface Finish

STATE highway departments are properly devoting increased attention to the surface finish of concrete highways. Thirty states now have clauses in their specifications limiting the allowable variation from the true surface contour. All but two states places the maximum allowable variation of ¼ inch and two place it at 1-16 inch. In 1920 only 21 states carried provisions in the specifications concerning this important feature and some states which in 1920 allowed a variation of ½ inch have reduced this to ¼ inch.

Not only are state specifications more definite in their requirements, but highway engineers are insisting that the specifications be fully complied with, making provisions for the enforcement of the clause. In at least one state, the surface is carefully checked before the pavement is accepted and all spots varying from the specified requirements are marked. The contractor is then required to bush hammer these places until the surface is satisfactory to the engineer.

Care in finishing is one of the most important requisites for a well-built concrete pavement. For maximum comfort, economy and durability of the pavement itself, the surface must be free from irregularities. Careful work and proper finishing methods will assure a true pavement surface. Once it has hardened, a concrete pavement "stays put." A properly finished road remains even, while a poorly finished road is a constant reminder of carelessness or lack of skill in construction.