

Concrete and Streets

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The use of concrete as a paving material is fast passing the experimental stage. Although it is doubtful if there is as yet sufficient information at hand to permit of a close approximation as to the life of concrete pavements under varying conditions of traffic, soil and climate there are particular cases of record showing the economy of this type of pavement after periods of actual use ranging from five years to ten years.

There are at least a few streets to-day in good condition after twenty years of service which would seem to show that if there were failures in the earlier work they could likely be traced to the same causes that will produce failures now. It is a fact, however, that there was more reason for attempting mixtures weak in cement then, for a barrel of cement cost from three to four times as much as now. In addition the remarkable increase in motor traffic during the last ten years has made it much more difficult to maintain those types of paving in which the various separate units are not held together by a positive binder as is the case with concrete. It has also greatly increased the life of concrete or similar surfaces because of the decrease in wear from rubber-tired vehicles as compared with that from horse-drawn, steel-tired traffic.

If it is granted that there must be some merit in a paving material the total yardage of which in Canada and the United States increased in 1913 from 9,000,000 square yards to 18,000,000 square yards and of which 16,000,000 square yards were laid during 1913, it ought to be worth while to note some of the facts that have been established by experience more particularly during the last five years.

Sub-Grade.

The fundamentals in road-building hold good for concrete just as for the other types. A system of drainage must be provided which will keep the water-level well below the sub-grade. This is especially true where frost has to be contended with. Where the natural soil is heavy clay or other material that is not self-draining there are certain advantages in placing the concrete upon several inches of gravel or other pervious material. If surface water does get beneath the concrete it then has a better opportunity to get away. In addition especially in hot dry climates there will be no trouble from cracks developing in the concrete slab due to the drying out and cracking of the sub-base material. This may occur when the concrete is laid directly on the natural soil. The sub-grade should be constructed with the idea of having it evenly compacted for the full width of the road section. This means special care where the concrete is replacing a highly crowned macadam road which was likely also not of as great a width as the new road will be. No doubt the bearing power of the soil can be greatly increased by careful rolling with a heavy roller, and this is certainly very desirable, but it is of at least equal importance that all parts be evenly compacted.

In order that the greatest thickness of concrete shall come where it is most needed the sub-grade should be flat up to a width of roadway that does not increase the thickness of the concrete slab at the centre unreasonably. With the crown usually given concrete roadways (1-100 of the width) the limiting width would be about twenty feet. Beyond this width the sub-grade should be slightly crowned so that the thickness of the concrete at the centre will remain constant.

Materials.

There is some difference of opinion as to whether it is the mortar composed of the fine aggregate and cement or whether it is the coarse gravel or broken stone that have to resist the wear on the road surface. It seems reasonable to suppose that both contentions may be right, that is, if a uniformly tough, hard fine aggregate is used with a comparatively soft coarse aggregate the mortar may take the wear while with the reverse conditions the wear may come on the coarse materials. With ideal materials both fine and coarse aggregates should be tough and uniformly tough, for it seems almost axiomatic that if construction is properly carried out the life of the pavement will depend directly upon the quantity and character of the traffic and the wear-resisting qualities of the aggregates. Materials that show uniform wear are certainly to be preferred over those containing some very tough and some very soft particles.

Proportioning.

While the proportions may be varied slightly according to the nature of the aggregates used in most of the work now being undertaken a mixture of about one part of cement to one and one-half parts of fine aggregate to three parts of coarse aggregate is specified. It seems strange that in road work there have been so few attempts made to get away from wheel barrow or bottomless box proportioning. It is one part of the work in which less progress has been made than in most of the others. There have been some exceptions notably one road in Oregon where the proportioning was done by bins at a central plant and three charges for the drum of the mixer carried in each car of the Industrial Railway train that was used to convey the material to the road. On one of the Maryland roads small dump cars were used in connection with a narrow gauge track. Partitions were placed in the cars so that one side of the car held exactly one charge of cement and fine aggregate and the other side the right quantity of coarse aggregate. Each car in this case thus held the material for one batch. Both schemes have been reported as satisfactory.

Mixing.

There has been wide variation in practice as to the time and speed required for mixing, but it is now realized that the number of revolutions per minute of the drum may vary with the type of mixer, the size of the drum and the nature of the mixture. For satisfactory results it is usually necessary to keep the batch in the drum for at least one minute. It is very desirable that a uniform mixture be secured. The concrete should be of such a consistency that it will stand without flowing when deposited. It should not be sloppy, but it should be wet enough to settle in place with the tamping that it receives from the strike-board.

Reinforcing.

No concrete road or street will be injured by the addition of reinforcing. It is almost certain, however, that all cracks of such a width as to be visible to the eye will not be prevented by the addition of the weight of reinforcing usually specified for concrete roadways.

Where subsoil conditions are bad, due either to the nature of the material or to the openings that may have been made for pipe lines there is value in reinforcing. Where the appearance of a road or street is of major importance reinforcing should be used. It is a question, however, if it has as yet been shown that reinforcing is economically justified for the usual widths of country roads where an occasional crack cannot be considered a serious fault.

Maintenance.

It has been said that the justification for the use of concrete lies in the low maintenance costs. With proper materials and workmanship the annual charge for repairs to the concrete surface should be small. There may be some surface pitting—there may be some cracks requiring attention; there likely will be some joints to be taken care of; on country roads there certainly will be shoulders to maintain and ditches to keep open. Undoubtedly some provision should be made for the maintenance of even a concrete road.

Costs.

Naturally the cost of the roadway proper will depend upon the cost of the cement, fine aggregate and coarse aggregate on the road and the labor cost for combining them properly and placing them in the road. The material costs will vary greatly with the distances they must be hauled. The labor costs will depend to some extent upon the organization. In rare instances where conditions are particularly favorable, the cost per square yard may be as low as one dollar. Usually the cost should be below one and one-half dollars. An average price in this vicinity will likely be in the neighborhood of \$1.35.

In conclusion, there is to my mind an analogy in concrete road building and the statement in mechanics that the work taken out of a machine cannot exceed the work put into it. In other words if a satisfactory road is to be built there must be a constant effort to secure the highest possible grade of concrete. Concrete is its own inspector. In concrete roadways concrete has its most severe test. The material is equal to the test, but it is at the mercy of the user.