

Passable thoroughfares stood the demands of traffic and served the immediate needs of the earlier settlers, but with the rapid development of the country, and the up-growth of townships and communities, the need for better highways of communication became not only necessary but imperative. A district settled up just as fast as the means of communication were extended, and developments kept pace with the road improvements. In short, roads came before towns and cities, and not until the townships developed into cities by easy stages and through many vicissitudes, did the modern city street as known to us arise and become standardized. In short, good roads and streets and higher civilization go hand in hand, each being interdependent on the other.

Macadam Road Construction.—In treating of macadam roads it is necessary to distinguish between water-bound macadam roads and bituminous-bound macadam roads. The former have been in adoption for about a century, and although the present methods employed in building water-bound macadam roads are entirely different, owing to the introduction of labor-saving devices, the principles underlying their construction are essentially the same. The first requisites for macadam road construction, namely, drainage, compactness of sub-grade, selection and grading of materials and consolidation of whole, are the same to-day as they were in the pioneer days of road building. The scientific, though commonplace, principles underlying the successful construction of the water-bound macadam road are:—

(1) The compression and compacting by rolling of the different sizes and shapes of broken stone (varying from foundation upwards) by knitting together and interlocking the rough angular surfaces of the stones.

(2) The application thereto by further rolling and sprinkling of a binding course of suitable material to cohere the whole, reduce the voids to the minimum and render the surface as wearing and as waterproof as possible.

Recognizing such fundamental principles it is not difficult to realize that the satisfactoriness and serviceability of a water-bound macadam road are principally dependent on the preservation intact, and as nearly as possible waterproof, of the wearing surface. The disintegration of water-bound macadam roads is, therefore, chiefly due to the ravelling action consequent upon long spells of drought which dries up the binding material, diminishes its cementing action and lays the aggregate underneath at the mercy of the destructive action of traffic.

The Effect of Speedy Vehicles.—The action of iron tires on slow-moving vehicles was not so severe on, and destructive to, such water-bound macadam roads, and with eternal vigilance necessary repairs could be made at comparatively small expense to keep such road in ordinarily good condition, and with further precautions of scarifying and resurfacing of such roads every two or three years they could generally withstand the ordinary wear and tear of traffic. The forces to which the roads were then subjected were strictly dead and live loads and of course impact, due to action of horses' hoofs and bumping of wheels in ruts and depressions. The speed at which vehicles then travelled being moderate, the live load on the roads was not then so appreciable and the impact not very high. Hence, water-bound macadam roads achieved their precious ends in successfully withstanding such physical forces. There was thus no immediate necessity for any better class of highway to accommodate the travelling public who were at that time generally satisfied.

But with the introduction of the automobile in the last decade, conditions entirely changed and engineers and authorities were confronted with the more serious problem of preserving the surface of the roadbed from the disintegrating and ravelling action of swiftly moving rubber-tired automobiles. The former methods of construction of water-bound macadam roads had necessarily to give place to the adoption of bituminous-bound macadam roads, the second stage in the evolution of the more modern hard-surfaced highway. Not only had the roads then to meet forces due to dead load, live load and impact and all these in a greater intensity, but also the more destructive and disintegrating forces of suction and shear.

Suction is the indirect result of the wind current and vacuum formed at the rear of the tires of a swiftly moving automobile. Such a force, or the resultant of such forces, tends to break the bond, loosen and disturb the binding particles in the surface of the road, and ultimately to disintegrate the roadbed.

Shear is caused by the tractive force exerted by the driven wheels of an automobile and naturally its intensity varies directly with the weight and speed of the automobile. Such a force has also a disintegrating effect on the surface of the roadbed. Since water-bound macadam roads have little or no resistance to the above action of suction and shear, it can readily be seen that it is imperative to build a road with binding material sufficiently strong and cohesive.

The more general use of the automobile also emphasized and increased the dust nuisance, so that attention had to be devoted to the dual problem of the preservation of the wearing surface, and the prevention or elimination of the dust. Various methods of applying different kinds of oils and emulsions, at different degrees of temperature, and under different conditions, have been adopted to bind together and consolidate the rock aggregate of the roadbed, and to abate, if not entirely eliminate, the dust nuisance. While many such preventive methods have met with a measure of success, they cannot be said to be generally and wholly satisfactory. While engineers and road experts are to be congratulated on the skill, ingenuity and resourcefulness, which they have adopted in their determined efforts to construct a bituminous macadam road, at low first cost, of passing serviceability, to meet the new problems associated with the changes of highways traffic, it cannot be justly maintained that the remedies, taking the all-important factor of maintenance into account, have been permanent.

Road Treatments.—The various "treatment" methods in vogue have afforded a temporary measure of relief, but as their ultimate success depends on frequent treatment, they are at the best only make-shifts, and costly at that. Referring to the oiling of roads, this was first adopted in California, where the local residual oils were used to counteract the destructive influences of the long drought on water-bound macadam roads, for while generally speaking water-bound macadam roads are not adapted to a humid climate, such as portions of the Pacific Coast, they are equally unsuited to such a dry climate as California. As already stated, a certain amount of moisture and dampness is necessary to keep the binding materials intact. The highest authorities agree that the best oil to adopt is a pure oil, unmixed with any other oils, and one having a natural asphaltic base. It is the asphaltic properties in road oils which, mixed with the aggregate or injected into the roadbed, binds the materials together and hold them in place, thus pre-