

creased to an excessive amount and diversion was applied, they rapidly became more and more dissatisfied.

Congress and eight or nine state legislatures that meet in regular session during 1936 will convene this month, and there are indications that most of them will consider legislation affecting the interest of motorists, particularly tax reduction.

In conclusion, I wish to lay stress on the point that with the curtailment of county road maintenance funds, two conditions will result unless we make proper correction. We know that with improper maintenance our county highways will eventually pass out of the picture, and, secondly, that unless the roads are properly maintained, the motorist is going to wake up to the fact that he is not getting what he is paying for and will demand a reduction of taxes. I believe it behooves us to recognize the seriousness of the situation and to begin to take immediate steps to correct it.

## ROAD WORK ON CONSERVATION PROPERTIES

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Indiana's Conservation Department is entrusted with the operation and maintenance of 68,000 acres of the state's holdings in parks, forests, game preserves, and fish hatcheries. These lands are operated by the three land-controlling divisions, namely, State Parks and Lands and Waters, Forestry, and Fish and Game. The Engineering Division acts as a service division to these three units, in addition to performing its statutory duties relating to drainage and flood control.

You represent organizations of the county and state having to do with construction and maintenance of county, state, and federal highways, which form a network of communication between the cities, towns, and villages of the state. These same highways, incidentally, are feeders to conservation properties. Last year a paid attendance of 770,000 persons visited state parks, with an estimated total of more than a million and a quarter visiting the conservation properties. Many of these visitors came from other states and many from our own. In either event, many thousands of dollars in gasoline tax monies came to Indiana's highways from conservation property visitors alone.

Roads and drives in conservation land areas are not the same high types of highways as those in the state system. They are designed for less speed and for passenger vehicles rather than for the heavier type of freight carriers common on all our state and federal highways.

In state parks, the principal drives are fitted to the ground forms encountered in the layout of the road. A real effort is made to keep from making deep cuts and fills—it is bent toward making a scenic drive rather than a high-speed roadway. As a matter of fact, a strenuous effort is made to limit the speed of all vehicles to 25 miles per hour or less.

In laying out park drives, this maximum speed of 25 miles per hour is used in figuring superelevation of curves. Vertical curves are designed to give the driver adequate visibility at all times. The drive is laid out with easy curves, and an effort is made to avoid compounding curves. This makes for easier driving and aids in handling traffic. Much of our park traffic is composed of cars driven by the comparatively inexperienced driver who has only an occasional Sunday for an outing. In the construction and maintenance of these park drives, guard rails are installed to protect the motorist in the event that he is careless or his car becomes unmanageable.

#### ROAD FUNCTIONS

All roads in parks have a definite purpose even though they may seem rather sinuous and meandering to those used to the design, construction, and maintenance of high-speed highways. This purpose is the leading of the visitor from the park entrance to the major scenic points of interest, the service area, picnic and camp grounds, and concession areas. By “concessions” are meant the lunch and soft-drink stands and hotels, such as are located in most of our parks. Roads which serve as service roads to water supplies, sewage disposal plants, wood yards, gravel plants, quarries, etc., are not stressed and are usually closed to public use. They are usually not laid out with the same degree of refinement nor constructed with the safety features found on the main drives.

In state forests, the principal road connects the nearest state or county highway with the service area and usually passes or leads to a picnic ground provided for public use. In the operation of the state forest, the primary considerations are the silvicultural work, namely, the cultivation of the hardwood and other useful timber trees, the elimination of weed species, the logging and sawing of these weed trees and those of stunted growth, and the fire protection programs. This latter work extends into the neighboring, privately-owned timber land and necessitates fire trails which connect with outside county roads as well as cover the state-owned areas. Picnic areas are incidental in state forests. They are supplied with potable water, furnaces, tables, and shelters and are connected with the main drive. They are furnished as a convenience to those desiring to view the plantings and forest improvement work which is carried on in each state forest as a demonstration of the methods that should be used by

the private land-owners in their woodlots or classified forest areas.

In game preserves, likewise, the principal road connects the nearest arterial highway with the service area of the preserve. This service area is the center of all operations and displays in the preserve, and includes wild game and animal exhibits, bird exhibits, rearing and holding pens for pheasants, quail, rabbits, and raccoons, water fowl displays, etc.

Fish hatcheries, being very compact in arrangement, have a drive connecting their service buildings with the nearest county or state highway. In some, a service road connects the pond areas of the hatcheries as an aid to servicing the ponds through the hatching, rearing, and fingerling distribution periods.

In the construction of all these roads, local materials are used if they are suitable. Specifications of the State Highway Commission of Indiana are used in all purchases of aggregates and in the production of materials from the conservation department's gravel plants and stone-crushers.

In planning drives in state parks, every effort is made to keep the grades to a minimum. In most cases, this is possible. At Clifty Falls State Park, however, it was found necessary to use a 12 per cent grade for a short distance on the new entrance road from State Road 56 near Madison. The average grade on this 4,400-foot length of road is 10 per cent. This grade, however, is unusual, as it is usually possible to keep below an 8 per cent grade on most of the park drives. Because of limited working space, it is not always possible to keep the degree of curvature within the limits considered best in state and county highway work. Usually, limits of curvature are kept low enough to prevent the roads being dangerous at a speed limit of 20 to 25 miles per hour.

In the construction of park drives, specifications are prepared that will give a road heavy enough to carry a great number of passenger automobiles and a few light trucks and busses. The use of loaded ECW trucks on the park drives has overloaded those constructed previous to the Civilian Conservation Corps movement and has caused an undue amount of maintenance. In construction which has been prosecuted since the advent of the CCC, heavier bases are being constructed on all drives and roads located in all properties.

The surfacing of each road varies with the materials available on the property involved. For instance, at Brown County State Park, Clifty Falls State Park, Morgan-Monroe State Forest, and Spring Mill State Park, where crushed stone is available and traffic warrants the expense, an oil-mat mulch surface has been applied to the macadam road already there. New drives at these places are constructed expressly for this oil-mat type of surfacing. At other properties, an oil-mat mulch has been built up on a gravel base. Stabilized surfaces

have been tried in the past few years, with gravel and clay as aggregates, and have been found satisfactory. Because of the rounded nature of the dune sand at Indiana Dunes State Park, it was found necessary to make all roads and parking areas of concrete slab. This is the only conservation property in which concrete construction was necessary. Every effort is made to keep the number of types of surfacing as low as possible in order to simplify the maintenance problem.

Maintenance of the oil-mat type of surface is handled through co-operation with the State Highway Commission of Indiana. This organization advertises and contracts for the application of tar or asphalt and chips and is reimbursed for this work and for labor, equipment, and supervision for the manipulation required.

Cross-drainage is usually handled by culverts without headwalls, with merely the planting of shrubs and vines to hide the exposed metal. During the past two or three years of Emergency Conservation Work there has been a tendency to add low headwalls of stone native to the park or forest in which the road is being constructed.

On locations where the cross-drainage requires a greater cross-sectional area than is available in pipes, combination metal and stone arches, stone arches, or small concrete bridges, all with stone or wood headwalls and railings suited to the property involved, are used extensively. Most of these structures give a well-balanced and pleasing appearance that goes well with park and forest types of construction.

Where stone headwalls are used, the random ashlar type of stone work is used. Examples of this type may be seen at Spring Mill State Park, Clifty Falls State Park, Martin County State Forest, and Ferdinand State Forest. In each, different types of stone are used, giving a variety to each property which is pleasing to the visitor. This is felt to be important in this phase of the department's construction work, as pleasing impressions cause visitors to advertise the property to their neighbors, thereby increasing attendance.

In larger structures where the span must be great in order to cut down excessive fills, rough-sawed timber trestles are used. Two have been constructed in the past three years by the Civilian Conservation Corps. One, with a span of 176 feet and a maximum height of 65 feet, is constructed of rough-sawed white oak timbers and carries a concrete road deck 22 feet in width. It is on the new entrance road at Clifty Falls State Park. A rough-hewn wooden hand rail completes this structure. The other is a structure of the same sort which is 160 feet long and uniformly ten feet high, and carries a 22-foot concrete roadway with two cantilevered sidewalks, five feet wide. It is at Indiana Dunes State Park. It carries a concrete camp ground over an arm of a swamp which is subject to floods.

Another larger structure which is somewhat unusual is a 54-foot oolitic limestone arch bridge, carrying a stabilized gravel road 22 feet wide with a five-foot sidewalk on one side. This bridge spans McCormick's Creek a few hundred feet above the falls and carries the picnic ground road from the hotel to the Beech Grove area. This structure was built by the CCC camp which was located there for a two-year period.

## PROGRESS IN SURFACE AND SUBGRADE STABILIZATION

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A thorough discussion of the subject of my talk would far overrun the allotted time, and I shall confine myself, therefore, to a hasty glance at past history, a review of our present practices, and perhaps a few suggestions as to the tendencies of the near future.

Accomplishments in the past have been retarded by a lack of a measure or yardstick for determining the relative values of respective soils. More recently, however, the U. S. Bureau of Public Roads has classified soils into groups easily identified by laboratory test, and various state highway commissions, the Highway Research Board, and other units have co-operated in the utilization of this classification in their investigation of subgrade and deep foundation conditions. The last five years have shown definite progress, and added information will become available at an international conference on soils and foundations to be held in Boston this summer.

According to the U. S. Bureau of Public Roads, as reported at the 37th annual meeting of the American Society for Testing Materials, the general status of soil investigation to date is as follows:

1. Disturbed soils and those close enough to the surface of the ground to be influenced by change of moisture, temperature, frost, etc., are tested in a dried and powdered state for shrinkage, plasticity, and similar properties, which disclose the characteristics of the soil constituents exclusive of soil structure.

2. Soils to be stabilized with admixtures or manipulation in practice are tested in samples prepared according to the construction procedure for properties required in stable fills, subgrades, and road surfaces.

3. Soils located below the line of seasonal change are tested by means of undisturbed samples in the laboratory, or by loading the soil in the profile for such engineering