Asphaltic Road Engineering

By W. R. Ellis

OUR roads and streets have developed step by step from wagon trails to the present day thoroughfares. The swift development of the automobile is causing a steady improvement in roadways. For every move that the automobile industry makes the road builders make a similar move to improve the many faults of the highways. The pavements are widened, the hazardous curves minimized and uniform grades maintained on the new plans.

Little do we realize while speeding down an elaborate highway the difficulties that the engineer encountered in its construction. Perhaps we are familiar with the materials used in the road but we have only a vague idea of the details. How was this smooth surface obtained? Were the curves super-elevated by eye? Were the fills and cuts guessed at? Did the engineer merely judge the amount of material to use? I'm afraid if roads were constructed in this manner no more enjoyment or satisfaction would be realized in traversing them than trying to pleasure ride on a wagon trail.

A thorough investigation of a road site is maintained before any plans are made. This investigation consists of a complete survey of the site by experienced location engineers and surveyors. The details, which are many, are then worked out in the engineer's office.

If an old pavement exists at the site of the proposed road it can be used to a great advantage as a foundation for the new material. Asphaltic concrete is a wise choice of material to use when such a base exists, for it gives durability and smooth surface. Where the old pavement is used as a base there is considerable amount of money saved. The expense of removing the old pavement or that of buying a new right of way is eliminated.

A new road today is seldom built less than 20 feet wide if it is to be a main highway. It is obvious that if the old pavement is only 16 feet that there is not enough of it to entirely fulfill the requirements as a foundation for the new pavement. The dirt and gravel, which form the berms of the existing road, are dug away. This exposes a vertical edge of about three to five inches of the pavement. The edge is swept clean and painted with an emulsion similar to black paint. Since this edge must come in contact with and adhere to the new material to be laid, it is the part which receives particular attention. Overhanging edges that will hinder new material from coming in contact with the old pavement are eliminated. It is better that this edge be inclined at about 45 degrees rather than vertical.

Steel forms with a base of at least eight inches and a vertical height of eight inches are set on each side of the road exactly ten feet from the center line of the proposed roadway. The forms are firmly staked to the ground. The alignment of the forms, as well as the grade, is obtained from the proposed plans. The line and grade are marked by stakes along the roadway set by a surveying party.

An insulation course consisting of slag, sand and metal filings is spread to a depth of one and three-fourths inches on the bare ground to be covered with three inches of new base. This insulation is uniformly spread and hand tamped. It would be more satisfactory if it was possible to roll this insulation with a power roller but the area does not provide ample space for such an operation.

Two crews of men are used in the construction of such a pavement. One crew sets forms, cleans the edge of the old pavement and spreads insulation. The other crew works at the finishing machine. Negro workmen are used at the finishing machine because white workmen cannot stand the intense heat of the asphaltic concrete which is between 250 and 350 degrees F. when it leaves the plant.

After the form crew has set about 400 or 500 feet of forms and the insulation has been spread, the roadway is ready for the first application of asphalt which consists of coarse aggregate and sphalt cement mixed proportionally. This is the new base course to be laid alongside the existing base to complete the twenty foot foundation. Three inches of this course are laid and rolled. This hot material binds and adheres to the existing edge of pavement. Experience shows that this course can be spread in less time by hand than by the use of a finishing machine. On a new

cut or fill where an entire new base must be built a finishing machine is used.

The materials forming an asphalt road cannot be all laid and rolled in one process. On top of the base or foundation three courses remain to be separately laid and rolled. Naming them in order, from bottom to top, they are: leveling course, binder course, and a wearing course. The thickness of each course is specified on the plans. Good figures to use are two and one-half inches of leveling, one inch of binder, and one inch of wearing. The reason for separately laying the courses is because each differs materially in composition. The leveling mixture consists of the same materials and in the same proportions as the base. The binder and wearing courses consist of the same materials, namely coarse aggregate, fine aggregate and asphalt cement, but combined in different weights. It is obvious that not as much coarse aggregate would be used in the top surface as in the lower courses. Certain specifications are required of the said mixtures and they are closely followed.

It may be the opinion of many people that anyone who knows how to operate a steam roller can roll an asphalt pavement and obtain a smooth surface. This rolling does not depend entirely upon the weight of the roller itself but upon the skill of its operator. Skilled rollermen are required to roll all of the courses. Since there is generally a crown of two inches in the surface of the road, the rollers must be maneuvered in such a manner so as not to destroy it. Two eight or ten ton rollers are used. When rolling close to the forms the rollermen have difficulty in keeping the roller from pushing the forms out of true alignment and yet getting close enough to the edge to press it down. The best of rollermen will occasionally bump into a form. The form setters come back immediately and reset such forms. The compression of the rollers will naturally spread the forms in all parts.

A simple device which helps in rolling close to the forms may be made from a board 12 feet by 15 inches by 2 inches. On either side of the board one end is cut in the shape of a wedge. The other end is equipped with some attachment which will enable the workmen to slide the board on the pavement. The board is placed lengthwise up close to the form with the wedged side up and the roller is run upon it and then off again. Thus the roller approaches upon the board easily. The board is then moved one length and the roller again rolls the portion under the board. By using such a device it is not necessary for the roller to come in contact with the forms.

The finishing machine used to spread the materials is screed action and mechanically operated. The wheels of the finishing machine have a flange on them. The tops of the forms are used as a track for these flanged wheels. The operation is similar to a train running on its track.

A gasoline blow torch is mounted on the machine where it can be conveniently reached by all the shovelers and rakers. The shovels and rakes are held in this flame and the material sticking to them may be readily removed.

All of the mixtures are delivered to the point of construction in five-ton dump trucks. The beds of the trucks are treated with an oil so that the hot mixtures will not stick to the beds. The trucks are equipped with tarpaulins to cover the material in case of rain or cold winds.

The materials are dumped onto a metal drag which is fastened to the rear of the trucks. In this way the truck may pull the drag along, yet keep in front of the finishing machine just far enough for convenience to the shovelers. The colored workmen, equipped with wooden shoes to protect their feet from the hot material, shovel the material from the drag to the roadway in front of the finishing machine.

A templet is used after every course is laid and rolled to check the forms for grade which might have been changed by the rolling. In order to obtain smoothness and uniform grade in a road with a given amount of material the use of templets is necessary. A templet is used directly behind the finishing machine to obtain a check on the thickness of pavement. This templet is merely a 20 foot board with one edge cut to form a curve which represents the crown of the pavement. The templet is set across the road perpendicular to the center line with the ends resting upon the forms. Measurements may then be taken from the lower curved edge of the board, which, resting in this position, corresponds to the correct elevation of the finished surface. If the binder course has just been laid and rolled there should be one inch between the curved edge of the board and the top surface. The one inch represents the remaining inch of wearing course to be laid. If this measurement is under or over one inch, not enough or too much of the binder course is being laid and it is obvious that the finishing machine must be adjusted.

Since only one course is applied at a time and the finishing machine moves much faster than the form crew is able to set forms, the machine must be moved back and forth. After running a course for a considerable distance

the crew moves back and lays the next higher course. Where the like mixtures are jointed together and one side of the joint has become cool a torch is used to reheat the cold material. The new material is then raked over the joint. The heat from the torch causes the materials to adhere together. An experienced raker can obtain a joint so that it is unnoticeable to the eye.

Occasionally there will be defects in the finished surface. These defects are usually results of an improper mix at the plant. All such spots are dug out and filled with new material.

From one to two hours after the wearing course has been laid and rolled the forms may be removed from the new pavement. The shoulders are still soft and unprotected. The road may be traveled but care must be taken that trucks or automobiles do not run out on the edges until the dirt berms have been constructed.

These berms are constructed of dirt extending six feet from each side of the road. Berm widths may not be specified as six feet but this figure combined with a three-fourths inch per foot slope away from the pavement are reasonable figures.

The type of pavement which I have described when completed is seven and one-fourth inches of compact water-bound material. It presents a smooth relatively non-skid surface which is even in texture and composition. The wearing quality of an asphaltic concrete surface is very great. I would prefer asphalt to concrete, especially on a new fill. Concrete, when placed on a new fill, generally cracks when the fill settles. A fill under an asphalt road may settle considerably without any noticeable effect on the pavement. An asphalt surface is also very economical from a maintenance standpoint.

There are many details other than those I have mentioned which an engineer encounters when building a highway. For instance, he must build within certain cost limits and yet turn out a pleasing piece of work. He must build a road that is adequate and durable for future use. His task is not a small one. Highway engineering is one of the major fields of engineering today.