SLOPE STABILIZATION of WEST VIRGINIA TURNPIKE

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●A HIGHWAY to breach the mountainous area in the southern part of West Virginia has for years been the dream of engineers and contractors who are engaged in the highway construction of this state. The tortuous route followed by our ancestors served the oxcart and wagon but, with the advent of the motor car and truck, man's thinking began to change and the steep grades and hairpin turns became woefully inadequate. Highways were straightened and grades lessened but an ever-increasing vehicular load still presented serious traffic problems.

In 1947 a new era in West Virginia transportation was born with the passage of a bill by the Legislature creating a Turnpike Commission with authority to proceed with the construction of a toll road. In 1949, with the appointment of a commission of five men, thinking crystallized into action. During the next three years, after long study and planning, the money was obtained for this first link in a turnpike system through the state. In August, 1952, the first grading contract was let, and two years and four days later, September 2, 1954, the first segment of 35 miles was opened to traffic. On November 8, 1954, the final 53 miles were opened, and the first link of a modern north-south highway was a reality.

When a person stops to reflect on the size of the undertaking, the following statistics come to mind. In order to build this highway some 31,750,000 yd. of excavation was required, 76 bridges had to be built, one of which is 284 feet above the stream bed. The bridge over Kanawha River is 2,166 feet long and 70 feet above pool stage. The Memorial Tunnel, linking two parallel valleys, is 2,655 feet long and is another of the major structures required. In order to preserve the grades and alignment desired for proper travel, 35 miles of existing state roads had to be relocated and rebuilt and 14.4 miles of creeks rechanneled. With all this massive construction underway, the planners, in keeping with the "new look," realized that with cuts up to 256 feet and embankments up to 110 feet something must be done to prevent excessive erosion. Thus roadside development came into the picture.

On March 25, 1954, the Roadside Development Department went into action, utilizing the latest equipment evolved in this field. Some preliminary work had been done in the fall of 1953 with a mulch spreader, such as had been used by various states for several years. A new method was brought to the market during this period. The idea of spreading the straw and tying it to the soil by the use of asphalt emulsion was almost too good to be true, as we had 87½ miles of highway to seed and only seven months to complete the job before the Turnpike was to be opened to traffic. After observing the various tests run on the machine, the Turnpike Commission purchased two of these machines and traded in our original machine for a third one. It was not long before we realized that even this revolutionary high-speed method was not the entire solution to the problem. The cuts and fills on this expressway were of such magnitude that the machine as delivered to us could not possibly cover the area involved.

We tried 100 feet of 8-inch tin pipe in 10-foot sections held together with homemade bands and materially increased the distance we could shoot the straw. On the 1:1 and 1½:1 slopes generally found on the cuts, even this pipe was unwieldy and hard to handle unless we used 8 to 10 men on the slope. Though we were able to increase production, the labor cost was excessive.

After continued study and search, we finally came up with an 8-inch aluminum

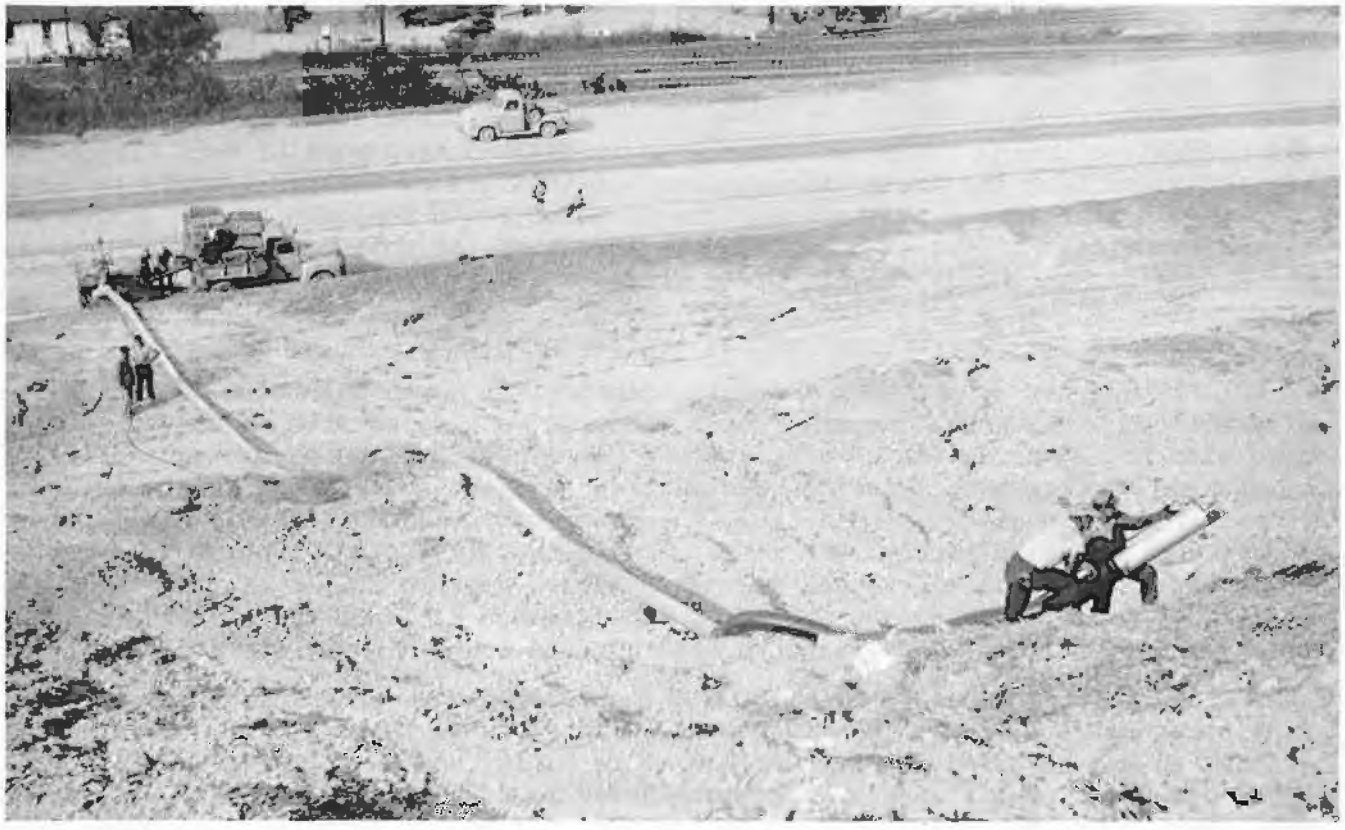

Figure 1. In many cases it was possible to mulch areas of approximately 60 feet in diameter some 230 feet from the mulch blower through the use of 8-inch aluminum irrigation pipe in 10- and 20-foot lengths. Even the 20-foot lengths could be handled readily by one man on steep slopes.

irrigation pipe held together by a rubber gasket and spring tension. We purchased 200 feet of this pipe in 10- and 20-foot lengths. Even in the 20-foot lengths, it was light enough for one man to handle on the steep slopes. In many cases we have used as much as 230 feet of this pipe and were still able to cover an area some 60 feet in diameter by utilizing a short piece of 8-inch flexible hose on the end. Even this proved inadequate to reach the top of some of the very high cuts.

The upper 200 to 300 feet beyond the limit of the blower was spread by hand, the men using the pipe to send the fluffed straw as far as possible, thus reducing the hand-carrying distance—again speeding up the work and reducing unit costs. In this manner we have spread as many as 195 bales, or 12¼ tons, of straw in one day, using a crew of six men.

Where the straw was spread without the extension pipe, the asphalt emulsion was incorporated with the straw as it left the pipe, thus making it a one-pass operation. Approximately 60 gal. of asphalt emulsion per acre were used. Within a matter of about 10 minutes the mulch was tied tight enough that wind and rain did not affect it. Where the extension pipe was used to place the straw on the slope, the asphalt emulsion was sprayed separately at the rate of approximately 80 gal. of asphalt emulsion per acre. In carrying out this operation, we have used as much as 450 feet of ½-inch rubber hose with nozzles on the end to spray the emulsion.

No mulch has been placed on this project without the tie-down of asphalt emulsion. Where we had to mulch behind the guardrail, the hand-spray method was used,

Figure 2. The idea of spreading the straw and tying it to the soil with asphalt emulsion in a single operation greatly speeded up operations.

so that the painting was not hindered or damaged. The loss to date by wind and water has been negligible.

The largest single day's production was 1,059 bales of straw (34½ tons) and 32 bbl. of asphalt emulsion, covering about 23 acres, using three mulch spreaders, six trucks, and a force of 19 men. The asphalt emulsion used was SS-1. The mulch was wheat or rye straw.

All seeding on this project has been done hydraulically. Following the dictates of nature, seeding has been carried out after the placement of the mulch, with excellent results. In the first place, we used a hydraulic seeder similar in design to many now in use. This machine was constructed for us by the State Road Commission on a rental basis. We soon realized it would not do the work at the speed required, because of the time lost in transit to and from a source of water, as in many places we had to go 5 miles or more to replenish our supply. This meant a loss of about an hour or more for each acre seeded.

With the aid of the Finn Equipment Co. we then developed a seeder mounted on a trailer, similar in design to the mulch spreader. This outift proved capable of dispensing the material in the same quantity and at the same pressure as the larger, more-cumbersome equipment. We were able to use two 1,000 gal. tanks, with agitators incorporated, mounted on dump trucks for the work, and thus we doubled our daily production.

In addition to speeding up the work, the tanks could be put aside when not required and the trucks used for other essential work. We got an output of 100 gal. of solution per minute at 100-lb. pressure and a distance of 125 feet; but again this proved inadequate to reach the tops of some of the cuts or the bottom of some of the fills properly to seed the area involved. We then attached as much as 200 feet of 1½-inch fire hose, using one and in some cases two men on the slope to handle the hose and nozzle. We found that, though we got fair coverage, friction loss cut down the distance and efficiency of the spray.

We are now using 100 feet of 2½-inch fire hose at the machine, reducing it to 1½ inches in the second hundred feet, with far more satisfactory results. We have by so doing increased our coverage to 300 feet. Where the area to be seeded is beyond this, we revert to the hand method of seeding and fertilizing.

As for the materials used, we have not gone far afiled, except in the case of fertilizers. In our original request to bidders we called for a fertilizer of 1-1-1 ratio based on an 80-lb. nitrogen equivalent per acre and soluble in water.

When the bids were opened, one vendor offered a 12-12-12 fertilizer which was 70 percent soluble in water, the balance going into suspension with only 0.24 percent failing to pass a 100-mesh sieve. By calling for new bids on the basis of

Figure 3. An output of 100 gal. of seed and fertilizer mixture per minute and a distance of 125 feet were possible with the hydraulic seeders used on the West Virginia Turnpike.

this new development, and after thorough testing, we were able to get what we required at a substantial saving and still retain a relative freedom of abrasion to the impeller of the pump. We were also able to reduce the cost of labor in handling as we could cut the amount required from 800 lb. on a 10-10-10 to 640 lb. per acre on the 12-12-12. As the work progressed, and checks were made, we found that only 500 lb. were being applied. The resulting stand was good and so we did not go back to the original specification.

The seed mixture for cut and fill slopes was as follows: 10 percent perennial ryegrass, 10 percent redtop, 15 percent Korean lespedeza, 15 percent domestic rye, 25 percent Sericea lespedeza, and 25 percent Kentucky 31 fescue.

At the very start of operations the decision to seed and fertilize after placing the mulch was questioned. In order to prove the point, I took four cuts of approximately the same height, slope, and soil structure and treated them in the following manner. Cut No. 1 was seeded and mulched, Cut No. 2 was mulched and then seeded, Cut No. 3 was mulched and then seeded with seed treated against soil organisms, and Cut No. 4 was seeded with the treated seed and then mulched. Cuts 2 and 3 showed a faster germination and better stand of about equal density. The added material did not increase the stand.

Because of the terrain that the road traversed, no seedbed preparation was possible and no topsoil was used on any area except at the interchanges and service areas where the more refined seed was used. Kentucky bluegrass and creeping red fescue were used instead of Sericea lespedeza and Kentucky 31 fescue. We were able to complete the seeding operations in many places before any pavement was placed. Generally we moved in immediately after the grading contractor and were out again before the base operations were finished. Often we had grass on the cut

and fill slopes before the paving equipment was on the job. Germination in 7 to 10 days was not unusual. Despite the fact that no additional fertilizer has been used, growth has been sustained and a very good cover has resulted.

We feel that much of the success on this project was due to our ability to get on the job before excessive erosion had taken place. We were able to complete our sequence of operations with a minimum of interference and were not forced to backtrack too much because we were in the contractor's way.

During the 30 weeks of full-scale operations we used the following materials: 2,145 tons of straw, 72,000 gal. of asphalt emulsion SS-1, 105,365 lb. of grass-seed, and 283 tons of 12-12-12 fertilizer.

Equipment used included: five 1½-ton dump trucks (International); one 2½-ton flat-bed truck (International); two 4-ton dump trucks (F.W.D., with 1,000-gal. tank with agitator, skid-mounted in bed); three mulch spreaders, 44-hp. motor with asphaltic applicator attached (Finn Equipment Co.); one Hydro Seeder, 44-hp. motor and pump (Finn Equipment Co.); and one pickup truck (Ford).

The labor force was composed of one foreman, three subforemen, eight truck drivers, four equipment operators, eight laborers, and two warehousemen, making a total of 26 men. This was the average force for the project, though we did reach a total of 30 men just before the dedication.

In the 30 weeks of work we covered 78 miles of the highway and seeded a total of 1,404 acres.

In the spring of 1955 all areas will be refertilized and where required re-seeded. All areas damaged by slides will be reworked and the last 10 miles completed. Fertilizer and seed rates will vary according to existing conditions at that time.

OBSERVATIONS

The time for erosion control is immediately upon completion of the grading operations. This may entail some repairs to the seeding after the paving and other essential work are completed; but it is actually more economical.

Soil preparation is costly and not necessary with this method of application, judging by the results we achieved. In a great many sections it would have been impossible.

Lime is not an essential to plant growth in most cases and we were successful in establishing growth in all conditions. A few scattered areas, totaling about 10 acres, however, will require lime this spring.

Mulch with asphaltic-emulsion tie-down may well relegate other methods to the obsolete. Hydraulic seeding and fertilizing on all areas is economical and will insure a uniform stand when used after mulching operations.