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VOLUME 9 NUMBER 3

Field Notes

The Problems of Using Standard Specifications Without Adjusting for Specific Design Conditions

Polypropylene Fabric as a Reinforcement of Muskeg Subgrades in Road Construction

Washington Office News

FOREST SERVICE MARCH 1977

U.S. DEPARTMENT OF AGRICULTURE

ENGINEERING FIELD NOTES

Volume 9 Number 3

FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE
Washington, D.C. 20013

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THE PROBLEMS OF USING STANDARD SPECIFICATIONS WITHOUT ADJUSTING FOR SPECIFIC DESIGN CONDITIONS

Gerald T. "Skip" Coghlan
Chugach N.F., R-10[1]

INTRODUCTION

In 1976, the Forest Service awarded a $165,703 contract to pave a campground road on the Kenai Peninsula in south-central Alaska. Final contract acceptance was complicated because all measured asphalt densities were below that specified. This report discusses how this problem was resolved.

PROJECT DESCRIPTION

The project included paving 0.97 miles of single-lane campground road, three parking areas, and 26 camping spurs. The typical section provided for 2 inches of hot mix asphalt-concrete over 4 inches of base on a reconditioned existing surface. *Forest Service Standard Specifications* were used, and Supplemental Specifications required that the contractor provide a mix design by the Marshall Method for light traffic as described by the *Asphalt Institute Manual, MS-2*. The Marshall Method for light and medium traffic requires 500 pounds minimum stability for the standard 4-inch diameter by 2 1/2-inch thick design specimen. The Supplemental Specifications also required that quality tests be provided by the Contractor through an independent materials testing laboratory.

Work progressed well, with a commercial test lab furnishing the quality tests. Following the Final Inspection, the core test results received showed adequate thickness but inadequate density. The densities of nine samples, as shown on table 1, ranged from 92.5 percent to 96.0 percent, while the specifications required 97 percent. Although a small roller had been necessitated by the tight quarters, rolling operations had appeared to meet standard construction methods and the same roller had just been used on another non-Forest Service project. Therefore, the low densities came as a surprise.

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[1]*Mr. Coghlan has recently transferred to R-9 as Regional Materials Engineer.*

Table 1. Densities of nine samples

Core No.	Thickness, inches	Compaction %	Adjusted stability pounds
1	2 1/4	95.0	837
2	1 3/4	93.2	523
3	1 7/8	96.0	1075
4	2 3/8	95.2	714
5	2	94.2	690
6	2 3/8	93.2	530
7	2	94.0	622
8	1 1/2	92.5	510
9	2 3/4	95.0	712
(Contract requirement was 97% compaction.)			

ANALYSIS

At this point, several alternatives were open:

The contractor could attempt to cold-roll the asphalt in an effort to gain the additional density.

The surface could be heated in place and receive further rolling.

Replacement or supplemental thickness could be required.

Reduced payment could be considered.

Any of these could have produced questionable results and made it difficult to resolve claims. What stood out were the reasonable construction procedures followed and the question of why we needed 97 percent compaction.

The primary purpose of the density test is to indicate constructed strength as compared to the design strength, or stability. The higher the density, the higher the strength; however, the actual correlation between density and stability was not known. The specified 97 percent was chosen from other contracts, rather than based upon the design criteria. If stability tests were run on the as-built asphalt, results could be compared directly to the design criteria.

The possibility of running Marshall Stability Tests on the density core samples was discussed with the Contracting Officer, the Contractor, and his testing lab. Measured stabilities would be adjusted by the ratio of the design standard thickness to the actual thickness for comparison to the design standard stability. A final decision on acceptance or rejection would be based on the results.

RESULTS AND DISCUSSION

Table 1 summarizes the test results. As adjusted, all samples exceed the 500 pounds minimum design stability.

Figure 1 compares the field sample densities with the adjusted stabilities and shows the expected strength-stability relationship. From the plot it can be seen that 92 percent or 93 percent would have been a more reasonable specification. For heavy traffic, the Marshall Method requires a minimum stability of 700 pounds. A 94 percent compaction specification would have been adequate for even the heavy traffic design criteria. The specified 97 percent would have given a stability of 1,250 pounds, or 250 percent of the minimum design stability. Because the 4-inch stability samples were made from the 6-inch field cores, the specimens most likely received undue disturbance, causing these test results to be conservative.

It was concluded that the in-place asphalt-concrete adequately met the design criteria and should be accepted. The situation also clearly showed the importance of properly selecting specifications and better correlating design and construction criteria.

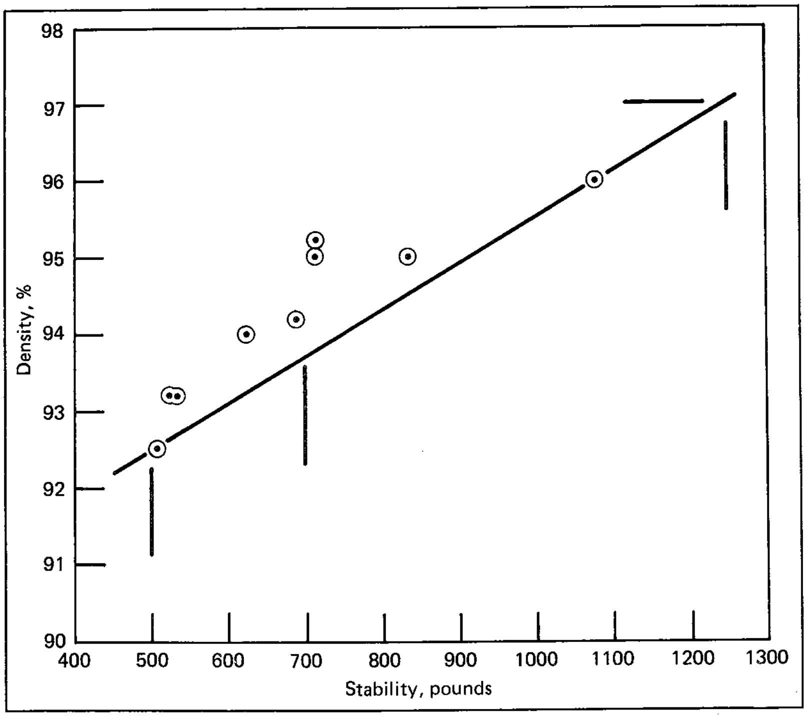

Figure 1. Field sample densities with adjusted stabilities.

POLYPROPYLENE FABRIC AS A REINFORCEMENT OF MUSKEG SUBGRADE IN ROAD CONSTRUCTION

Morris Lively, Civil Engineering Technician
Stikine Area, Tongass National Forest, R-10

and

William A. Vischer, Materials Engineer
Willamette National Forest, R-6[1]

Forest Service road construction in southeast Alaska involves extensive crossings of muskeg terrain. Most of the roads are constructed using overlay techniques and "shot-rock" or pit-run embankments. The costs involved in crossing such weak subgrades increase rapidly due to excessive deformation and settlement of the subgrades. The majority of the road construction cost (i.e., 80 percent) involves the production and installation of the "shot-rock" embankments. As a result, economical construction techniques which provide reductions in rock quantities can significantly reduce construction costs. Any method of reinforcement, bridging, or floating over the peat deposits may be feasible, depending on the particular peat characteristics, applicable rock costs, and construction techniques used. Because of the relatively low cost of fabrics (i.e., 50¢ to $1 per square yard), even a slight savings in rock quantities can easily justify this type of reinforcement in terms of economics.

To evaluate the benefits of such fabrics for this type of road construction, a test section using the low cost fabric was constructed and monitored on the Tongass National Forest, 20 miles south of Petersburg, Alaska. Various embankment sections with and without the fabric reinforcement were constructed and monitored to determine the differences in performance.

The project site and subgrade characteristics, prior to construction, are shown in figures 1 and 2 respectively. The fabric used was a needle-punched, spun-bonded, polypropylene material having a weight of 420 gm/m^2 and a strip tensile strength of 86 pounds per inch. The trade name of the product is Fibretex 400, distributed by Crown-Zellerbach Corporation.

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[1] *Mr. Vischer was the Regional Materials Engineer in R-10 at the time of the test project. He has since transferred to R-6, Willamette N.F.*

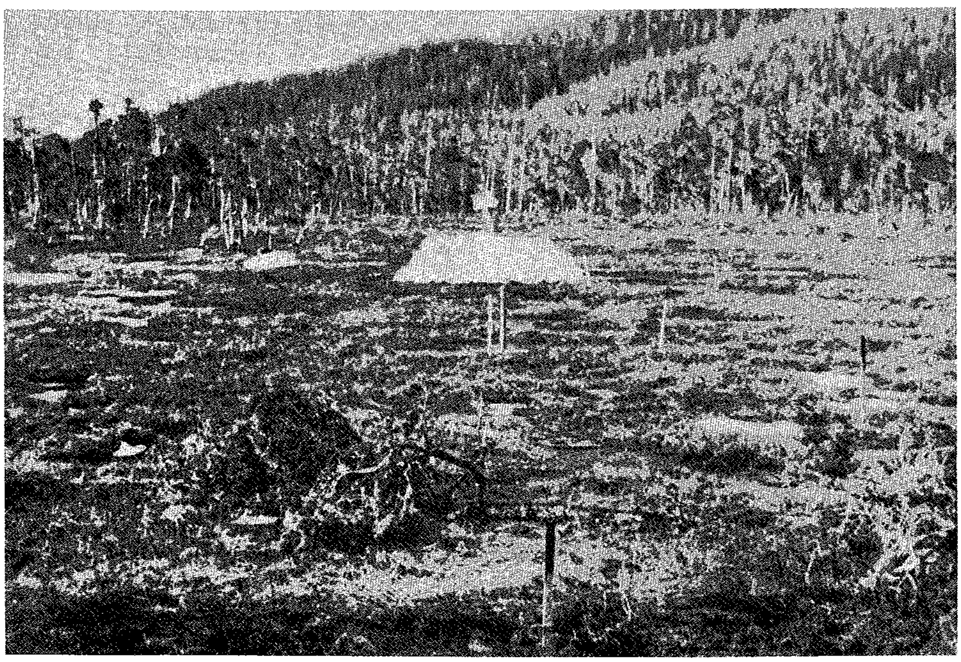

Figure 1. Project site prior to construction.

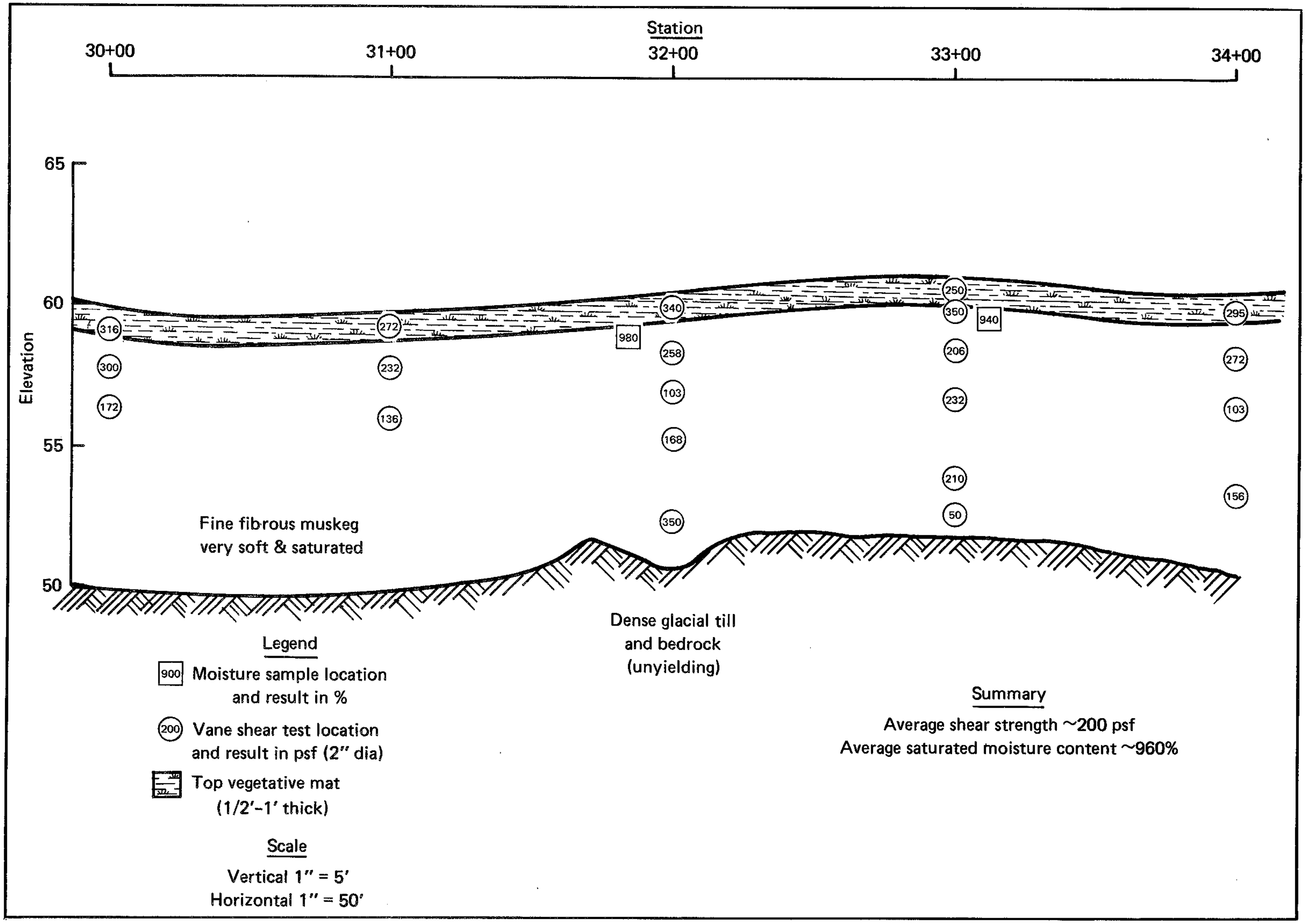

Figure 2. Soil profile and test results.

The overlay construction techniques are illustrated in figures 3 and 4. A Cat-loader (Model 977L) with a gross weight of 41,000 pounds was used for spreading the rock embankment, while dump trucks (tandem axle/dual wheel) with a gross weight of 80,000 pounds were used for hauling the rock. Figures 5 and 6 summarize the as-built conditions of the road. For a more detailed discussion of the techniques, see footnote[2].

As indicated by figures 5 and 6, the fabric reduced rock quantities substantially in some areas. Based on the as-built road cross-sections, a potential reduction in rock quantities of about 23 percent could have been realized throughout this area if fabric reinforcement had been used over the full length. On subgrades requiring 3 feet of fill and more, this results in significant savings.

In two separate cases where reinforcement was not used, substantial displacements due to bearing capacity failures occurred as indicated by the profiles and cross-sections at stations 30 + 59 and 32 + 60.

The exact mechanics of the fabric-reinforced peat have not been fully documented or explained in terms of the stress-strain relationships developed in each material. This is due to the limited field instrumentation and materials testing data available on such projects. Based upon the limited documentation on this project, a theoretical analysis of the results was made by D.R. Greenway and J.R. Bell of Oregon State University[3]. The intent was to obtain a better understanding of the reinforcement mechanism. Their report, as well as the documentation report by W. Vischer[2], suggests that the decreases in settlement of the fabric sections were not due to decreases in consolidation type settlements, but rather to settlement or displacement associated with local bearing capacity failures. The fabric apparently provided sufficient tensile strength on the weak peat to enable the embankment to act as a unit, rather than allowing localized bearing failures. The negligible difference in settlement between the double-matted section (from stations 31 + 75 to 32 + 00) and the single-matted section (between stations 32 + 00 and 32 + 40) appears to indicate also that a single mat layer was sufficient to preclude these localized failure displacements; hence, the additional layer in the double-mat section apparently provides no additional benefits.

In summary, this test section has provided some general direction to R-10 for future muskeg subgrade reinforcement with fabrics. The results indicate that if the peat is relatively strong (i.e., shear strength of 250 psf or better), few benefits would be derived by using fabric to reinforce

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[2] *Vischer, W.A., Use of Synthetic Fabrics on Muskeg Subgrades in Road Construction, USDA, Forest Service Report, Region 10, November 1975.*

[3] *Greenway, D.R. and Bell, J.R., Analysis of a Low Fabric Reinforced Embankment on Muskeg, Department of Civil Engineering, Oregon State University, Corvallis, Oregon, June 1976.*

the muskeg subgrades on roads in southeast Alaska. Fabric, however, could probably produce some benefits on amorphous peat deposits, or weak silt or clay deposits which are highly susceptible to pumping. The fabric would serve as a filter barrier against pumping to preclude contamination and weakening of the rock embankments or base course. J.E. Steward's report on "Plastic Filter Cloth"[4] discusses this in detail. The peat deposits in southeast Alaska, for the most part, appear to be the organic type rather than the amorphous type, thus significant benefits in this area are not foreseen.

For analytic approaches on predicting the benefits of fabric reinforcement on muskeg terrain, the reader is again referred to the reports by Vischer[2] and Greenway and Bell[3]. Based on the test section data, these authors prescribe design analysis and prediction methods for engineers involved in such designs.

Figure 3. End dumping pit-run rock. The area shown illustrates the results of a typical bearing capacity failure. Severe subsidence of the road embankment and upheaval of the adjacent muskeg occurred immediately. Note the lack of water on the unvegetated muskeg in the foreground; that bare area had about 6 inches of groundwater covering it immediately prior to end dumping.

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[4] *Steward, J.E., Use of Woven Plastic Filter Cloth as a Replacement for Graded Rock Filters, USDA, Forest Service Report, Region 6, June 1976.*

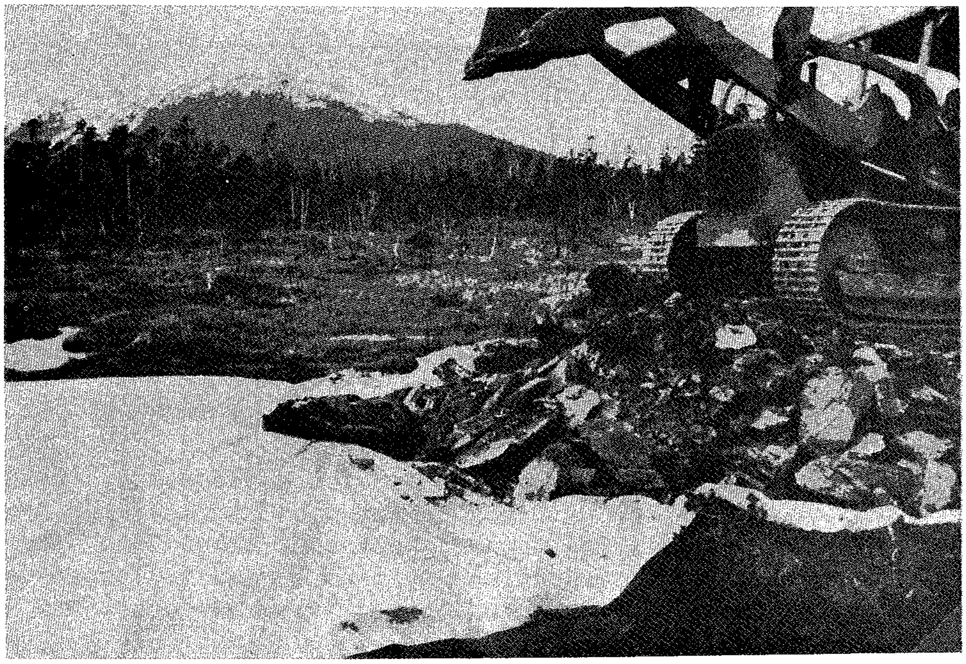

Figure 4. Spreading the pit-run rock.

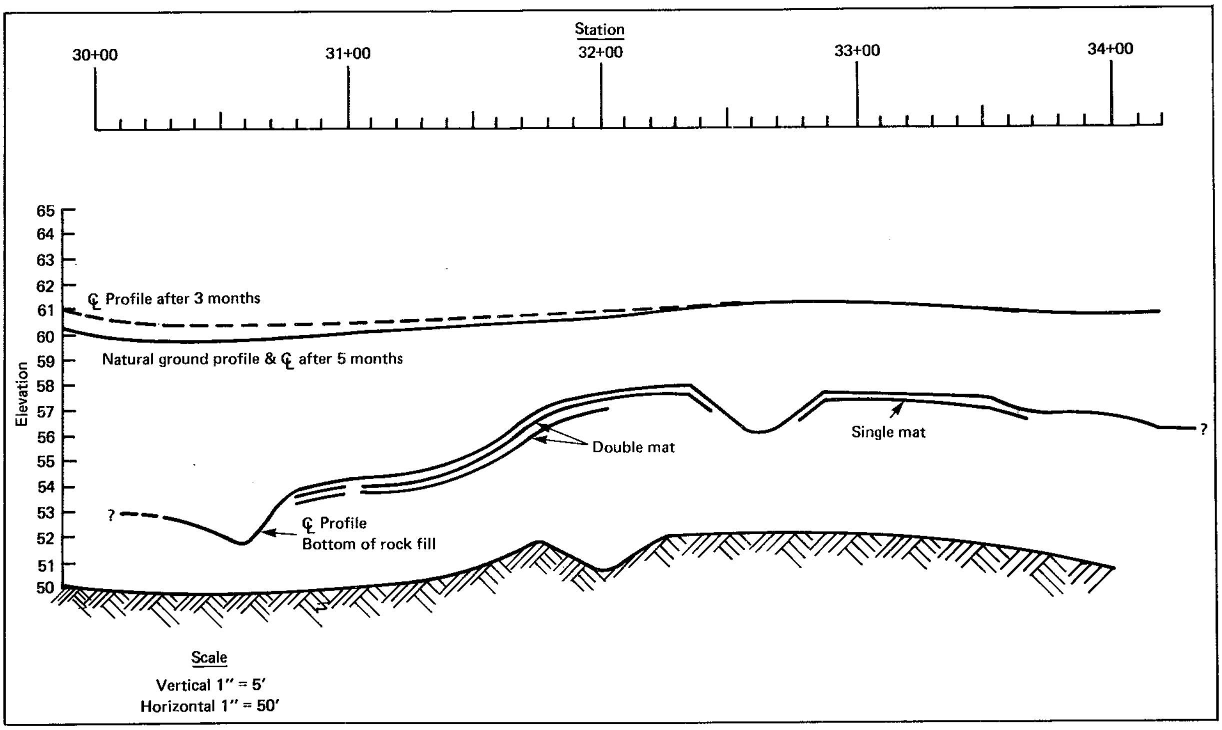

Figure 5. Embankment and soil profile after construction.

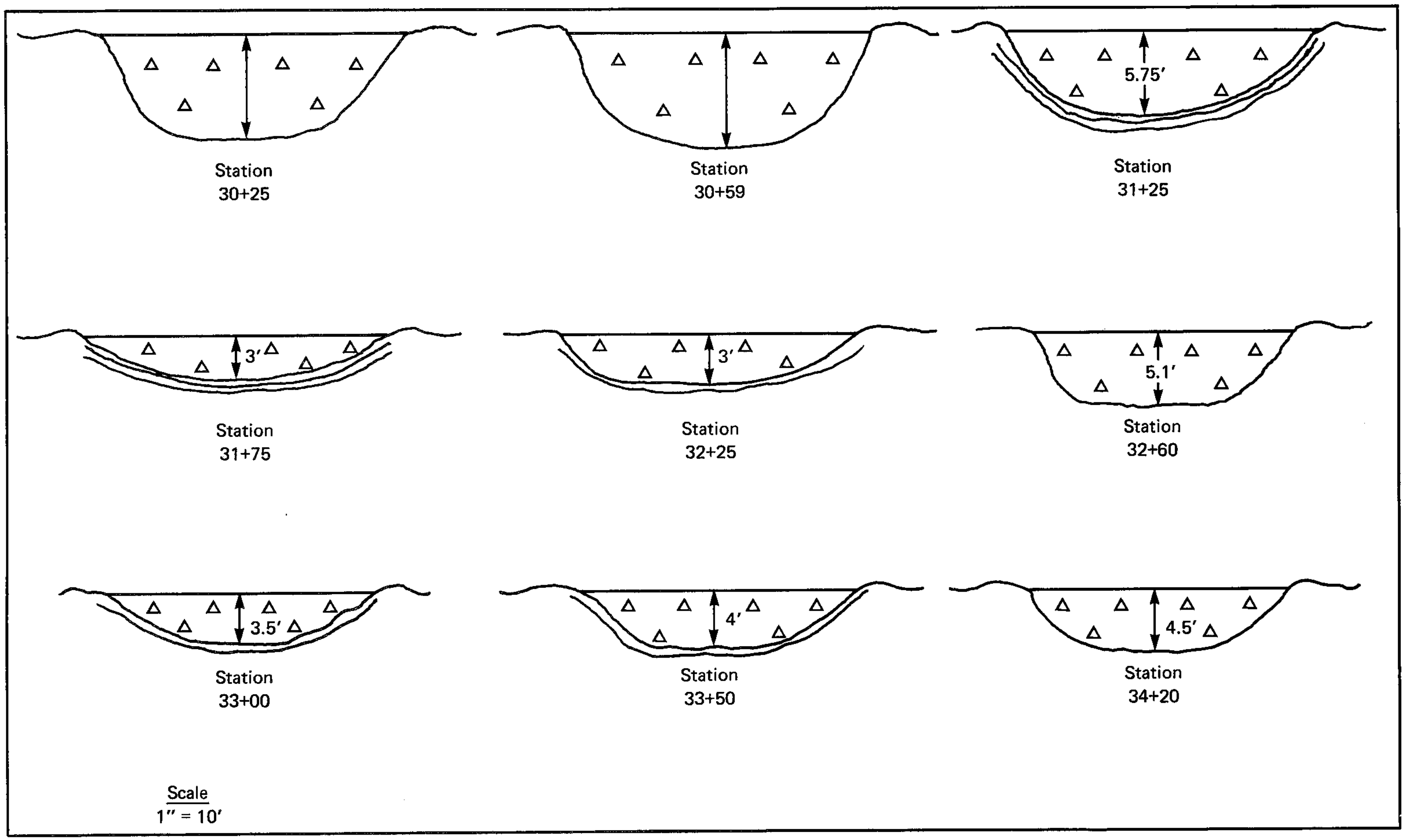

Figure 6. As-built embankment cross-sections.

WASHINGTON OFFICE NEWS

TECHNOLOGICAL IMPROVEMENTS

Heyward T. Taylor
Assistant Director

DOCUMENTATION OF ROAD DESIGN SYSTEM (RDS)

The first progress report on our cooperative agreement with Colorado State University, a joint effort to document the Road Design System (RDS), has been received. The report indicated that in addition to making the RDS easily transportable from one machine to another and efficiently maintainable on all machines, the corrected documented version will produce considerable savings in machine costs regardless of which machine it operates on.

The information is in the first quarterly report of the first phase of the documentation. We anticipate three phases will be required to complete RDS documentation. The report gives the results of benchmark tests conducted on the original RDS, and tests conducted on the implemented documented version. These tests indicate that on the documented version a savings of $14,000 in machine time will be made this year; additional savings will be realized in subsequent years. The progress report also indicates considerable savings can be realized in the time required to maintain and keep RDS operating. The RDS modules modified by the documentation have cleared up ambiguities. They have also eliminated redundant or obsolete codes and improved results of data manipulations which have been implemented.

If the cooperative agreement continues at the same level, we can expect to complete RDS documentation and have a system less costly to operate, easier to maintain, and ready for efficient transport to the new USDA computer hardware, scheduled for delivery in 1979.

CONSULTATION AND STANDARDS

C.R. Weller
Assistant Director

COMPATIBILITY OF ELECTRICAL EQUIPMENT WITH ELECTRIC SERVICE

One problem we often have in the field is that electrical equipment does not match the characteristics of the electric service supplied by the power company. This most often occurs when the electric supply is rated 120/208 volts, three phase, four wire.

The 120/208 volt system permits the use of both single-phase and three-phase equipment. We should make sure that the equipment to be used with this kind of service is rated 120 or 208 volts, and not the more common 230 or 240 volts. Electric motors should operate satisfactorily on plus or minus 10 percent of the rated voltage; e.g., a 230-volt motor should run sufficiently on 207 volts. In rural areas, however, the voltage often drops below its 120/208 volt rating, and this can cause problems if you try to operate 230- or 240-volt equipment on a nominal 120/208-volt system.

Check with your power company to make sure that the equipment to be used matches the voltage and phase characteristics of the electric supply.

OPERATIONS

Harold L. Strickland
Assistant Director

EMERGENCY RELIEF FUNDS

Under Title 23, U.S.C., Section 125, the Secretary of the Department of Transportation is authorized to repair or reconstruct roads and trails that have suffered serious damage resulting from natural disasters or catastrophic failures.

As a result of a major storm in California, the Administrator of the Federal Highway Administration and the Chief of the Forest Service entered into a Memorandum of Understanding on March 14, 1969, to expedite the repair of roads and trails damaged by natural disasters. The Memorandum of Understanding outlines administrative procedures each agency will follow in the event a disaster affects forest roads and trails.

Basically, the procedures are:

1. Immediately after a disaster the Chief asks the Administrator for a "finding" of eligibility. In so doing, he must provide the Administrator:

   The date of the disaster.

   The location by State, county, and forest.

   The approximate cost of repairs.

   Information on whether or not there is a State or Presidential proclamation of the disaster.

   While the Chief is asking for a "finding," Regions or Forests begin preparing individual project damage descriptions and cost estimates.

2. The Administrator issues a "finding." If the damage is eligible for Emergency Repairs Federally-Owned (ERFO) funding he approves the program, usually in the amount of the Chief's request, and asks for a summary of projects. The summary must contain preliminary estimates and descriptions of damage.

3. The Region submits the summary to the Chief, who submits it to the Administrator. The Administrator approves individual projects and

notifies the Chief that funds for approved projects will be transferred to FS.

4. Regions promptly initiate repairs and inform the Chief of actual project costs. This enables the Chief to request program adjustments from the Administrator.

5. As work progresses, FHWA makes spot checks.

6. At conclusion of work associated with a specific storm, the Region submits a final construction report to the Chief. The report must show, project by project, the amount approved by the Administrator and the amount actually spent repairing the project.

7. The Chief will request a final program adjustment from the Administrator based on the information in item 6.

Several Regions and Forests are experienced in the ERFO program area; however, others who need to apply for ERFO funds may find the following information helpful:

1. Federal-Air Highway Program Manual, transmittal 196, dated June 9, 1976. The transmittal outlines the purpose, limitations, eligibility requirements, etc. of the ERFO program, and should be used in conjunction with the 1969 agreement.

2. Natural Disaster Manual, Part 2, written for Region 8 FHWA, Portland, Oregon. This manual goes into more detail than transmittal 196.

3. Work of an emergency nature done during or immediately following a disaster to protect lives and property, or to keep critical access open, is fully reimbursable by FHWA.

This relatively simple procedure has made it possible for FHWA to contribute over $77 million since 1969 towards the repair of damaged forest roads and trails.