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Field Notes

Use of Reinforced Earth Company's Retaining Structures on the Olympic National Forest

The Brownhouse Study Road

Washington Office News

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

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USE OF REINFORCED EARTH COMPANY'S RETAINING STRUCTURES ON THE OLYMPIC NATIONAL FOREST

Dave Erwin[1]
Civil Engineer
Rogue River National Forest
Region 6

The use of Reinforced Earth[2] retaining structures for small walls on the Sitkum-Soleduck Road Reconstruction Project on the Olympic NF in spring of 1976 proved to be an economical and efficient alternative to conventional retaining walls.

Reconstruction of the Sitkum-Soleduck road was a condition of the Camp Timber Sale on the Soleduck Ranger District, Olympic NF; it required three small retaining structures. All three structures were needed to correct problems associated with settlement of previously-sidecast material, narrow road, and steep sideslopes for a paved mainline haul road. The selection criteria alternates were established as follows:

1. Retaining walls must be permanent structures, since the road receives continuous use, except when blocked by snow.

2. Visual Resource Management allows use of any type of structure.

3. Walls must accept high differential and total settlements. These walls will be built on low-strength, highly-variable native soils ranging up to 12 feet in depth.

4. To reduce failure of the asphalt surfacing, walls should permit only a minimum settlement of road surface.

5. Since the walls are to be constructed under a Timber Sale contract, the construction methods should permit the use of skills and equipment that are locally available to all purchasers.

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[1] *Mr. Erwin was stationed at the Olympic National Forest at the time this article was written.*

[2] *Reinforced Earth Company.*

6. Design time constraints. Forest Service Engineering personnel would be able to complete the design within time limitations.

7. Construction must be economically viable.

8. Because of local traffic needs, the road must not be closed for any extended length of time.

Preliminary investigations, designs, and cost estimations were reviewed in relation to the established selection criteria and resulted in the design and contract of Gabion-type retaining structures.

The Purchaser of the Sale (M&R Timber, Inc.) and his subcontractor (Delhur, Inc.) both of Port Angeles, Washington, in conjunction with the Reinforced Earth Company, submitted alternate designs using metal-faced Reinforced Earth structures for all three retaining walls.

Engineering review of the alternate structures was made by the Forest and Regional Offices and resulted in minor adjustments of the original designs submitted by Reinforced Earth Company. The major revision required double-dip galvanizing of the reinforcing straps to protect against corrosion in the slightly acid soil backfill.

Construction of the three walls began on May 25, 1976, and was completed by June 7, 1976. During the erection of the first structure, the Reinforced Earth Company sent a representative to the job site. Excavation consisted mostly of unsuitable silty sand soil types and woody debris. Suitable sources of native backfill material were not available, so open graded 3-inch minus crushed rock was used for backfill.

Structure excavation was accomplished with a hydraulic backhoe with a 3-1/2 yd^3 bucket. The base for the structure was prepared by placing a leveling lift of the 3-inch minus crushed rock, and by compacting it to a density equivalent to 90 percent of AASHTO T-99 method C (fig.1). Successive layers of facing elements, reinforcing strips, and backfill were then placed (fig.2). The backfill was end-dumped, spread in 1-ft. layers, and compacted with a small vibratory compactor to within 2 or 3 ft. of the wall face. The backfill adjacent to the wall face was placed with hand shovels and compacted with a hand tamper. Prior to backfilling and compacting of each layer, wooden wedges were placed between the layers of facing elements. The wedges kept the facing element from tilting as the backfill was placed and compacted against it (figs. 3 & 4).

The top layer of reinforcing strips were bent downward and placed on top of the strips in the layer below, thus preventing outward tipping of the top facing element. Two feet of crushed rock was placed above the top of the wall to distribute wheel loads to the top layer of reinforcing strips. This top layer also serves as a surcharge to develop the friction in the top strips when no load is on the structure. The Reinforced Earth Company indicates that compaction of the backfill material is not necessary for developing the friction in the reinforcing strips. The requirement for 90 percent density of backfill was necessary only to prevent excessive settlement of the backfill, which would produce failure of the asphalt surfacing.

Finished-in-place cost of these structures (fig.5) ranged from $15/ft^2$ to $18/ft^2$ of facing. Significantly lower costs could be expected for walls where a nearby source of suitable native backfill is available. The backfill for these walls was crushed rock which had to be hauled 3 to 6 miles from the source. The actual construction time averaged 2-3 days per wall; the walls averaged 80 feet in length and 12 feet in height. To date, no significant failures have occurred in any of the structures.

The Olympic NF has since constructed another wall (fig.6) of similar design only larger, and has experienced costs similar to that of the first three walls. The main advantages of this type of permanent wall are:

1. Low cost

2. Speed of construction

3. Use of standard construction equipment

4. Low bearing capacity required for the wall footing.

Figure 1. Excavation and base for structure.

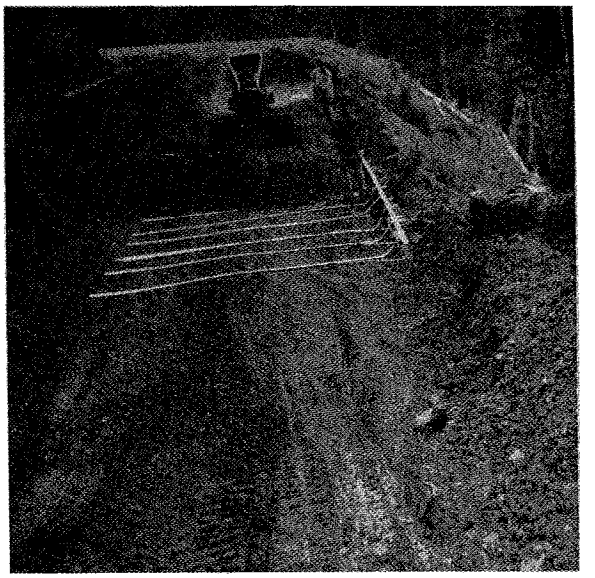

Figure 2. Placement of facing elements, reinforcing strips, and backfill.

Figure 3. Wedges in place at bottom of wall.

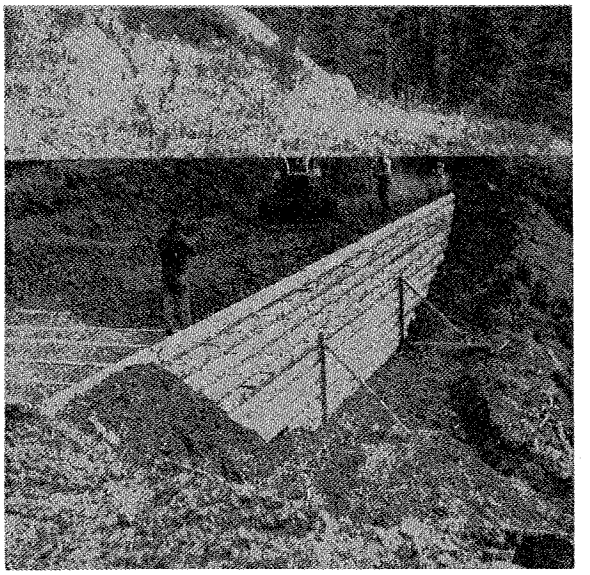

Figure 4. Wall prior to completion of backfill for top layer. Note the wedges in place on top half of wall, and the batten boards used to align the wall during erection.

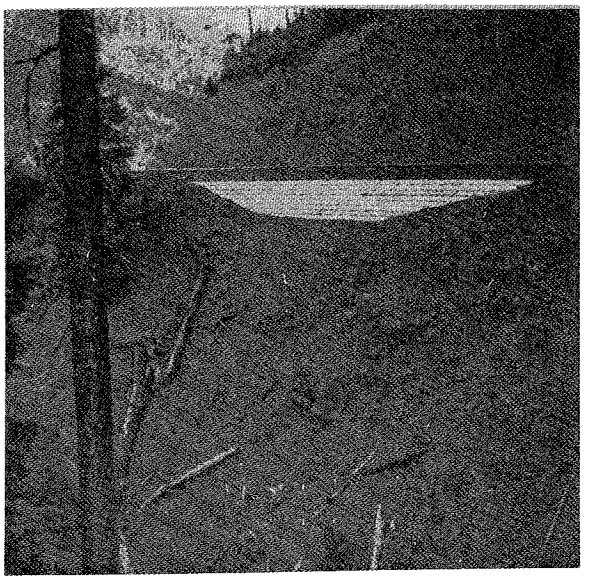

Figure 5. A view of finished wall.

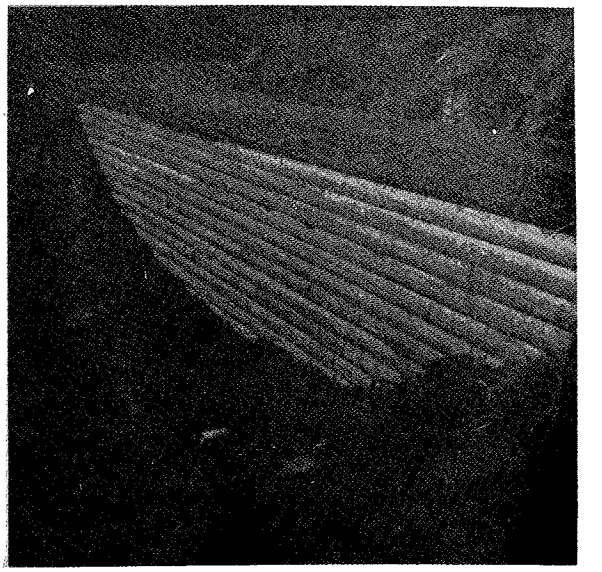

Figure 6. Retaining structure on Hunger Ridge Road (Rd. 2970), with dimensions of 120 ft. x 20 ft.

THE BROWNHOUSE STUDY ROAD

B.D. Franklin
Materials Engineer
Region 8

Soils on the Apalachicola National Forest near Tallahassee, Florida, are of fine, almost-uniformly graded sand and are classified as A-3 by the AASHTO method. When used on a roadbed, the sand becomes unstable in dry weather. For years, local pit-run sand clay was used to stabilize the surface of sand roads; however, suitable sand clay has become difficult to find.

In 1963, engineers of the National Forests in Florida constructed the Brownhouse Study Road on the Apalachicola NF. The purpose was to develop economical and practical methods for surfacing forest roads.

There are 20 sections, each 500 feet long, on the Brownhouse Study Road. None of the sections are identical. However, the base on each section, including the surface, is 4 inches thick. The results of this study indicate that the 4-inch depth is adequate.

Two in-haul aggregate materials were used on the study road:

1. Limerock, which is a soft rock used by the Florida Highway Department for bases; and

2. Local sand clay, which is an A-2-4 material used by the Forest Service to stabilize the in-place sand.

These two materials were combined 1:1 with the sand, or were used alone for the 4-inch depth. Limerock was used on nine sections, and sand clay was used on six sections. Five sections had bases which were 100 percent in-place sand.

Four treatments were used on the various sections to stabilize the sand:

Portland cement was used on two sections.

Three asphalt products were mixed to various depths with the base on seven sections.

The same asphalt products were used as a penetration treatment on seven sections.

Four sections received no stabilizer.

Performance of the study sections was determined by condition surveys made by a team of observers at predetermined intervals. At the end of 5 years, four and one half sections were still in good condition. The half section was composed of sand mixed with cement and covered with 2 inches of sand to protect the surface from direct contact with the tires. One section was sand mixed with SMK asphalt emulsion. The other three sections had SS-1 asphalt emulsion mixed in the top 2 inches of the base. The bases for the three sections are respectively: half-and-half limerock and sand; 100 percent limerock; and 100 percent sand clay. After 5 years the team recommended any of the five successful methods to surface Forest roads in Florida.

The condition of the study sections on the Brownhouse Road was not inspected regularly after 1968. In autumn of 1976, a condition survey was made of the study sections. Particular attention was paid to the sections which were in good condition in 1968. All of these sections needed resurfacing in 1976; however, the sand asphalt section was in better condition than the other sections. There was some fine alligator cracking along the edges and wear and loss of surface material, especially in the outside wheelpaths. The surface of the section was tight.

The section with a base of limerock and sand mixed half-and-half and SS-1 asphalt emulsion mixed in the 2 inches was on a curve. There was extensive cracking along the inside shoulder and several potholes which cut through the stabilized layer. Alligator cracking extended for 30 feet at one end of the section.

The section with a base of solid limerock and 2 inches of the surface mixed with asphalt emulsion was badly cracked with a spacing of 3 to 6 inches. The top ½ inch of the surface was beginning to scale from the material below. The section with a base of solid sand clay and SS-1 asphalt emulsion mixed in the top 2 inches had numerous transverse and longitudinal cracks, breaking the surface into blocks from several inches to 4 to 6 feet in size. There were many potholes, mostly small, but some as large as 2 by 3 feet in size. Some surface loss was caused by traffic, making the surface irregular.

There have been no base failures on the Brownhouse Road, although heavy timber and minerals traffic have traveled it.

Some of the conclusions reached as a result of this study are briefly:

1. In-place A-3 sand mixed with asphalt has excellent possibilities for use on Forest roads.

2. Penetration treatments were ineffective and are not recommended for use with A-3 sands.

3. Double bituminous surface treatments placed on selected base perform very well.

4. Soil cement cannot be used as a surface, since it abrades badly. It makes a good base, however, if protected by a surface treatment.

This information is condensed from previous reports. For further information contact B.D. Franklin, RO, R-8.

WASHINGTON OFFICE NEWS

CONSULTATION AND STANDARDS

Charles R. Weller
Assistant Director

NEW FOREST SERVICE GENERAL PROVISIONS AND SPECIFICATIONS FOR CONSTRUCTION OF ROADS AND BRIDGES

The National Forest Management Act of 1976 (NFMA) will result in significant impact on the Engineering job related to road construction for timber sales.

Section 14(i) of the Act provides that:

> (1) For sales of timber which include a provision for purchaser credit for construction of permanent roads with an estimated cost in excess of $20,000, the Secretary of Agriculture shall promulgate regulations requiring that the notice of sale afford timber purchasers qualifying as "small business concerns" under the Small Business Act, as amended, and the regulations issued thereunder, an estimate of the cost and the right, when submitting a bid, to elect that the Secretary build the proposed road: *Provided*, That the provisions of this subsection shall not apply to sales of timber on National Forest System lands in the State of Alaska.
>
> (2) If the purchaser makes such an election, the price subsequently paid for the timber shall include all of the estimated cost of the road. In the notice of sale, the Secretary of Agriculture shall set a date when such road shall be completed which shall be applicable to either construction by the purchaser or the Secretary, depending on the election. To accomplish requested work, the Secretary is authorized to use from any receipts from the sale of timber a sum equal to the estimate for timber purchaser credits, and such additional sums as may be appropriated for the construction of roads, such funds to be available until expended, to construct a road that meets the standards specified in the notice of sale.
>
> (3) The provisions of this subsection shall become effective on October 1, 1976.

For future timber sales, the builder of the specified road will not be chosen until a successful bidder on the timber sale contract is determined. Then, if the timber purchaser elects that the Secretary build the road, the Forest Service must be prepared to respond rapidly in order to meet the completion dates. The road must be built to the specified standard for any procedure used.

A Forest Service task force was organized to develop procedures to comply with Section 14(i). The task force unanimously agreed that the key to implementation involved development of new FS Specifications for Construction of Roads and Bridges, which could be used to build the roads by either a timber sale or public works contract. With that objective, a FS work group of contracting officers, timber specialists, design engineers, and construction engineers drafted proposed Specifications. These have since been reviewed by the Regions, timber industry representatives, and others.

The Chief has approved the task force's proposal that the Forest Service use a single set of Specifications for timber sale and public works road construction. The Specifications will be printed and bound in book form. To make them usable in both types of contracts, a new set of General Provisions has been written for each and incorporated into the book. In new timber sale and public works contracts, the appropriate General Provisions and Specifications will be made a part of the contract by reference.

Effective date of the new Specifications is July 1, 1977. A limited number of preliminary copies will be shipped to Regions about April 25 for use in training and preparing new contracts. Printed copies will be shipped from GPO on May 27.

The book will be available to the public at $5.65 per copy from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402; it is carried under GPO stock number 001-001-00425-1.

CADASTRAL ENGINEERING

Amendment 43 to FSM 7150 has added considerable flexibility to the standards for boundary marking and posting of Forest Service property and should be helpful to the management of this program.

By spring, new chapter FSM 7150 is expected to be published, with a Forest Service handbook to follow next year. These will provide additional direction to the expanding program.

A set of *National Standard Specifications for Cadastral Survey Contracts* is being developed to facilitate contract preparation and assembly and should be available before the summer field session. FSM 6300 should also be amended to include some new direction for implementing these professional service contracts.

OPERATIONS

Harold L. Strickland
Assistant Director

A STANDARD FOREST SERVICE SCALE FOR RESOURCE AERIAL PHOTOGRAPHY

Programs and activities in all agencies and at all levels are being scrutinized in a continuing effort to eliminate duplication and reduce unnecessary government-wide expenditures. One area that has been singled out as having high potential for coordination and standardization is aerial photography acquisition. The potential to avoid duplication and cut costs is quite significant when you consider how many State, local, or federal agencies, as well as private industry, use aerial photographs as a tool to get their jobs done. There have been examples where as many as five different organizations, including the Forest Service, have flown aerial photography at varying scales over one area in one season. Each agency has established the scale appropriate to its individual needs and will staunchly defend that scale.

The problem is to arrive at some commonality of scale which can satisfy the major requirements of agencies needing photo coverage over the same geographic areas. The Department of Agriculture is attempting to do that with its agencies.

Except for specific project application, the Forest Service has two aerial photography requirements: high-altitude and low-altitude (or resource). It is generally accepted that 1:80,000 is the preferred scale for high-altitude photography in the Forest Service, and this scale will continue to be supported.

Resource aerial photography is an invaluable tool for the Forest manager, because it aids in maintaining a current inventory of Forest resources and supporting facilities. Prior to 1968, nearly all photography obtained was black-and-white; but with the advent of color, the Regions have converted in order to use the advantages of color for interpretative purposes. Now, nearly all resource photography is flown in natural color. Presently, there is no Forest Service standard defined for resource photography, although much of what we have acquired is at a scale of 1:15,840. However, the improved camera systems, film emulsions, and technology have led to a reevaluation of the resource photography program.

These improvements allow the use of smaller scale photography with little or no loss in interpretative value. Several Regions have discovered this and have adopted 1:24,000 as their standard for resource photography. The cost of original acquisition of 1:24,000 as compared to 1:15,840, is considerably smaller because of the reduction (about 33 percent) in miles flown. A reduction (about 50 percent) in the number of photos to reproduce and handle add to this savings, which is estimated at 40 percent overall.

Our multilayered mapping system as defined in FSM 7140, establishes the 1:24,000 scale as the Primary Base to which all layered resource and other information is to be tied. The use of 1:24,000 scale photography greatly facilitates photo-to-map base or photo-to-resource layer transfer and reduces the dependency on sophisticated photogrammetric equipment.

Most other agencies within the Department of Agriculture generally use a smaller scale (around 1:40,000) to satisfy their requirements. This scale, of course, would allow cost savings over the 1:24,000 in acquisition and reproduction. However, at this stage of technological development, 1:40,000 will not satisfy Forest Service interpretative requirements.

It is evident that standards for aerial photography need to be established within the Forest Service. It is also evident that scales of 1:80,000 for high-altitude and 1:24,000 for resource photography will be supported Service-wide. This will not preclude the use of other scale photography for special or unique requirements. The adoption of 1:24,000 scale as the standard will not only result in a substantial savings to the Forest Service, but will greatly strengthen our position when Departmental standards are developed.

TECHNOLOGICAL IMPROVEMENTS

Heyward T. Taylor
Assistant Director

For over 10 years, the American Society of Agricultural Engineers (ASAE) has recognized forestry engineering as an engineering discipline, and has chartered a Forest Engineering Committee, PM-55, in the Society. Forestry engineering, as recognized by Agricultural Engineering, is closely related to engineering performed by FS Equipment Development Engineering.

A number of FS Equipment Development Engineers have joined other forestry engineers in active participation in PM-55 Forest Engineering committee meetings. PM-55 was chartered in 1964 and was active for a few years, but interest and attendance dropped off. Renewed emphasis on resource development has given PM-55 new life, and it is now an active, aggressive committee. Its membership includes representatives of government agencies, forestry and engineering schools, equipment manufacturers, and forest industrial companies. It sponsors several technical sessions at each of its annual winter meetings that deal with a wide range of subjects related to forestry operations.

Engineers from the Equipment Development Centers have always participated in PM-55 Committee activities. Boone Richardson, now Director at San Dimas, was one of the first chairmen. Since then, Dan McKenzie, SDEDC; Ray Hemphills, formerly SDEDC, now R-8; Farnum Burbank, SDEDC/MEDC/WO; and Dick Hallman, MEDC, have been full-time members of the Committee and have held various offices. Forest Service personnel actively participating in the Committee functions are from Engineering Research and Equipment Management. In addition, other FS Engineers and Foresters have contributed technical papers.

Other technical committees in ASAE offering opportunities for technical information exchange are the Nursery and Greenhouse Mechanization, Agricultural Chemical Application/Aviation, and Tractive and Transport Efficiency.

ASAE recognizes the specialized nature of forestry equipment operations and provide an outlet for FS professional engineers to present and exchange information about forestry engineering activities. In so doing, it performs an important service to our forestry equipment development operations. The committees schedule two meetings per year: June and December. Anyone

interested in an agenda, or in extra copies of technical papers, may contact a FS committee member from those previously identified.

One other important event in our equipment development work last year was the recognition by the California State Board of Registration for Professional Engineers of forest equipment engineering as an Agricultural Engineering option for professional registration. This action paved the way for the registration of our professional equipment engineers at RO's, MEDC, SDEDC, and WO.