

**ENGINEERING  
TECHNICAL  
INFORMATION  
SYSTEM**

FIELD NOTES • TECHNICAL REPORTS  
DATA RETRIEVAL • MANAGEMENT  
PROFESSIONAL DEVELOPMENT

VOLUME 11 NUMBER 2

**Field**  **Notes**

**Unified Rock Classification System --  
Clarification and Amendments**

**Forest Transportation Analysts --  
Job Performance and Training Requirements**

**The Use of Corrugated Metal Culvert Liners  
to Minimize Stream Bedload Effects**

**Washington Office News**



**FOREST SERVICE**

**FEBRUARY 1979**

**U.S. DEPARTMENT OF AGRICULTURE**





## **ENGINEERING FIELD NOTES**

Volume 11 Number 2

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

*Unified Rock Classification System--Clarification and Amendments*, listed on the cover as the first article, is printed as the last pages of this issue to facilitate removal.

## FOREST TRANSPORTATION ANALYSTS--

### JOB PERFORMANCE AND TRAINING REQUIREMENTS

*Victor DeKalb  
Chief Transportation Engineer  
Consultation & Standards  
WO*

Last September, the *Steering Committee for Training Forest Transportation Analysts* submitted its report to the Chief. It included a listing of Job Performance Requirements and suggestions for a Service-wide effort for training Forest Analysts. Forest Transportation Analysts are involved in long-range, wide-area planning as well as short-range, specific project planning. The Job Performance Requirements and the new training program must reflect both these activities.

#### *JOB PERFORMANCE REQUIREMENTS*

A draft of the Job Performance Requirements is being reviewed. They will be carried in a later issue of the *Field Notes* to permit the broadest possible comment from the field before they are put in the *FS Directive Handbook*.

#### *TRAINING PROGRAM*

The current training program for Forest-level Transportation Analysts is being conducted at Richmond, California, through a co-operative agreement with the University of California.

Region 1 is preparing a Service-wide training package and material to conduct the Richmond program on a continuing basis by means of a contract with an academic institution or other training organization. There is still considerable work to do in evaluating needs, costs, and opportunities before a final selection is made of the training institution and schedule developed for the new courses.

The course consists of eight independent training modules. A table, *Modules in Transportation Analysis Course*, is provided here for your review. Any or all of the modules can be included in a person's schedule as appropriate to meet the minimum requirements for qualification as a Forest Transportation Analyst.

MODULES IN TRANSPORTATION ANALYSIS COURSE

| Number | Length<br>(days) | Prere-<br>quisites* | Description                                                                                 | Training Objective                                                                                                                                          |
|--------|------------------|---------------------|---------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | 2½               | -                   | Traffic performance characteristics on Forest roads                                         | Itemize concepts and ground rules of which Transporations Analyst must be aware to specify feasible and desirable alternatives.                             |
| 2      | 2½               | -                   | Introduction to roading and yarding standards and logging systems                           | Identify feasible and desirable logging system alternatives at a level of detail appropriate for forest planning.                                           |
| 3      | 2½               | -                   | Traffic surveillance methods                                                                | Compile necessary data for analyzing existing transportation conditions through inventory, surveillance, estimation, and validation.                        |
| 4      | 2½               | -                   | Laws, policies and organization issues associated with transportation analysis              | Become conversant with constraints and powers concerning transportation that are contained in Forest Service directive system.                              |
| 5      | 5                | 4                   | The Planning process, organizing for analysis, selecting planning criteria and alternatives | Develop technical skills required to organize and design a transportation analysis effort properly, including overall relations to forest planning process. |

|   |    |       |                                                                                  |                                                                                                                                                                                  |
|---|----|-------|----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6 | 10 | 4,5   | Transportation network and link analysis techniques                              | Analyze transportation alternatives selected for study, using such techniques as link coding, travel times, cost indices, vehicle restrictions, etc.                             |
| 7 | 5  | 4,5,6 | Techniques for evaluating alternatives and displaying analytical results         | Evaluate transportation alternatives and documentation of study; includes economic indicators (i.e., present worth), nonmonetary effects, and display techniques.                |
| 8 | 5  | 4,5,7 | Funding of transportation investments; introduction to programming and budgeting | Understand need and format of final study as process for obtaining funding for implementation of study, as well as understand other inventories and documents affected by study. |

*\*The individual must pass pretests for the prerequisite modules before being considered for training in any module. Regions or Forests also might want to administer the pretest for any modules planned for the employee to determine if the need for training is indicated.*

The course material being developed for 1980 and thereafter will qualify specialists in the various phases of Transportation Analysis performed at project, area, or Forest levels. The course is designed for specialists who are at the GS-7 level and above, have a background in Transportation Engineering, and are (or will be) working primarily in Transportation Analysis and related planning functions. Other specialists who have analytical experience and training will be considered as candidates for the course.

January through May is the tentative training schedule for 1980, with the Western States as the chosen location. Firm schedules and selection of the site will be announced by October.

THE USE OF CORRUGATED METAL CULVERT LINERS  
TO MINIMIZE STREAM BEDLOAD EFFECTS

*Robert D. Hulet*  
*Civil Engineer*  
*Mt. Baker-Snoqualmie National Forest*

*THE PROBLEM*

During seasonal heavy rains and resulting high runoff conditions, mass bedload movements occur on numerous streams on the Mt. Baker-Snoqualmie National Forest. In many instances, the gravel bedload, passing through the metal pipe drainage structures that are installed to transport streams under Forest Service roads, causes rapid deterioration of the corrugated pipe. As the material is carried through the pipe, it contacts the corrugations, which are perpendicular to the streamflow, at relatively high velocities. Eventually, the peak corrugations are worn through and a "venetian blind" condition develops at the outlet, extending back toward the inlet of the structure. If not detected at an early stage in road fills constructed of fine-grained materials, this condition results in varying degrees of road structure failure.

*A SOLUTION*

Replaceable corrugated metal culvert liners were installed to reduce pipe wear and the effect of deterioration on the segment of road involved. Presently, two such installations are functioning successfully on the Mt. Baker-Snoqualmie National Forest.

In a typical installation (figure 1), a 58-inch by 36-inch (147.3 cm by 91.4 cm) pipe arch is used as a cross drain structure; 12-gauge corrugated metal sections 48 inches wide and 117 inches long (121.9 cm by 297.2 cm), overlapped and bolted together, line the invert of the pipe arches. The inlet end of this liner assembly protrudes past the end of the pipe arch and is bolted to a prefabricated concrete slab; the concrete acts as an anchor, holding the entire liner in place. When the bedload movement causes the liner to wear out, the bolts in the concrete anchor can be removed, the original liner assembly pulled out by using a cable, and a new liner installed.

Even if the concrete anchor slab is damaged as the liner sections wear, replacing both is far simpler and less costly than restoring the eroded road fill material and replacing a conventional drain-

age structure. Field observation shows that the liners do not wear out as rapidly as conventional culverts because the corrugations are parallel to the stream flow.

### BENEFITS

Three of the major benefits that result from use of the liners:

1. Direct material and installation costs for the replacement of wornout liner sections are only approximately 25% of the total cost of replacing an entire conventional culvert and the eroded road material. This cost difference probably will become much greater as labor and equipment rates continue to increase.

2. Replacement of the corrugated metal culvert liners is a relatively simple and straightforward task that can be performed by Forest Service maintenance crews without specialized equipment.

3. Replacement of only the liner assembly eliminates the disruption of traffic flow that occurs when the entire drainage structure is replaced and the roadbed must be reconstructed. This factor is more significant where the reconstruction must be made on the more permanent types of road surface, such as asphalt concrete.

### A RELATED DEVELOPMENT

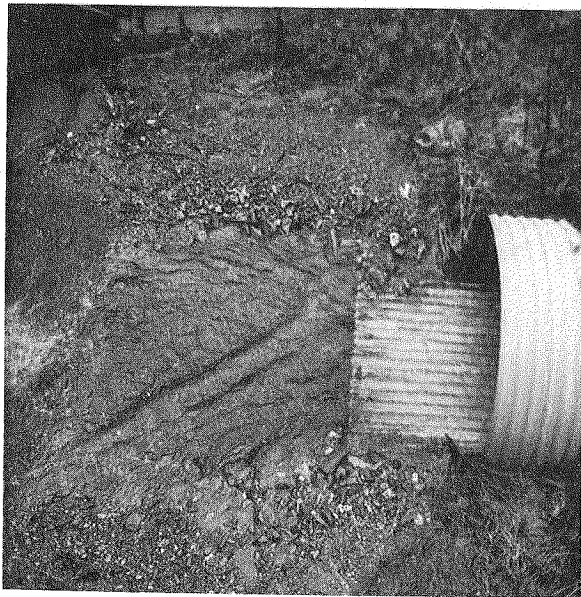
Some concepts developed for the replaceable culvert liner were incorporated in the modification of a downdrain accessory.

Previously, an open rectangular "downflume," 24 inches (61.0 cm) high and 58 inches (147.3 cm) wide, was lined with replaceable 12-gauge steel panels that were similar to the replaceable culvert liners. The stream bedload moved in a high velocity streamflow down a 67% slope, causing rapid deterioration of the corrugated steel liners. The most severe deterioration of the downflume liners was observed at a particular section that measured 24 inches (61.0 cm) wide by 120 inches (304.8 cm) long.

Lining the inside of the downflume with 10-foot (3.0 m) sections of treated timber planking (figure 2), rather than the steel liners, reduces replacement costs. Each 4-inch (10.2 cm) by 12-inch (30.5 cm) plank, individually secured to the steel structure by bolts, can be easily replaced as it wears out.

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The replaceable liner described in this article was designed by *Robert D. Hulet*, Civil Engineer, and *Robert G. Barnard*, C & M Superintendent, Mt. Baker-Snoqualmie National Forest, and *Earl Hanson*, District Engineer, San Juan National Forest, formerly Design Engineer on Mt. Baker-Snoqualmie National Forest.



*View showing the inlet of the pipe arch, concrete anchor slab, and replaceable corrugated metal liner connection.*

*View showing the position of the replaceable corrugated metal liner at the outlet end of the pipe arch.*



*Figure 1*



*View of downflume with  
treated timber liner  
installation from top  
of fill slope.*

*Close up view of downflume  
showing in greater detail  
the treated timber planking.*



*Figure 2*

WASHINGTON OFFICE NEWS

CONSULTATION AND STANDARDS

Walter E. Furen  
Assistant Director

FS GENERAL PROVISIONS AND STANDARD SPECIFICATIONS  
FOR CONSTRUCTION OF ROADS AND BRIDGES  
1977 REVISION--STATUS REPORT

The May 1978 issue of *Field Notes* explained the process and schedule for planning the revision of the 1977 edition of the *FS General Provisions and Standard Specifications for Construction of Roads and Bridges*. The committee members working on the project were listed, and suggestions from the field were solicited.

Two questions were raised by the committee:

1. Have we had enough experience with the 1977 edition?
2. Is a 1979 revision premature?

These questions were considered carefully in relation to the Regions' experiences of about 1 year, and the suggestions received from all sources.

It was determined that the following items should be accomplished soon:

1. Correct errors;
2. Standardize wording;
3. Update technical materials and references;
4. Eliminate duplication and ambiguities;
5. Simplify procedures;
6. Reduce problems in contract preparation and administration;
7. Reduce need for Regional Specifications; and
8. Standardize and include Engineering Specifications for items such as Construction Staking.

There would be some advantage in waiting to gain more experience in construction by using the 1977 edition; however, it is believed that the benefits derived by earlier improvements will outweigh other--and undetermined--possible advantages. Therefore, it has been decided to proceed with the revision as outlined in our original plan.

The project is on schedule; a final review draft will be sent to the Regions approximately May 1, 1979 and the printing will be completed by August 31, 1979. The package containing instructions, directions, and policy for implementation of the 1979 edition of the *Specifications* will be forwarded to all Regions by October 1, 1979.

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#### CADASTRAL TRAINING

Two new cadastral training programs in support of the expanding boundary survey program were developed this winter. In January, about 25 Cadastral Surveyors from all Regions attended a 3-week college "quick course" in Denver covering boundary survey requirements and the survey system in the United States.

A 2-week *Boundary Survey Law* course will be held at both Florida University (March 11-24) and Fresno State University (April 2-13) for other Forest Surveyors. Both of these courses are for college credit; if all goes well, they will be offered again next year.

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#### FIELD TABLES

The *Engineering Field Tables* (EM 7100-10) book is being prepared for reprinting; we solicit any additions or corrections you may have. Please reply to WO Engineering no later than May 15, 1979.

## UNIFIED ROCK CLASSIFICATION SYSTEM

### CLARIFICATION AND AMENDMENTS

The changes listed below are intended to clarify the article "Unified Rock Classification System," which was published in the November 1978 *Field Notes*, and the changes should be incorporated into the text as directed.

Pages 8, 10, and 12. Each of these pages has been revised and reprinted for direct insertion into the text. Each revised page should be trimmed to size and stapled securely to its corresponding page, completely covering the old page.

The following changes should be made in ink directly on the pages of the original article.

Page 11, paragraph B. In the first sentence of the paragraph, the words "is present" should be revised to read "occurs." In the last sentence of paragraph B, the phrase "maximum unit of weight" should be revised to read "maximum unit weight."

Page 13, paragraph C. The following sentence should be inserted between the last sentence of the paragraph and the one immediately preceding it: "Dent Quality material produces fill that is not free draining (impervious) and is not suitable for road aggregate material."

Page 16, last paragraph. In the next-to-last sentence, the words "Rock with a 150 pcf" should be revised to read "Rock less than 150 pcf."

A reduced version of the table and text on pages 8 and 9 are provided and may be cut out and put into your Pocket Handbook for on-the-spot reference.



**UNIFIED ROCK CLASSIFICATION SYSTEM (URCS)**  
**ROCK MASS STRENGTH ESTIMATE - BASIC ELEMENTS**

EFFECT OF WEATHERING

| WEATHERED (1)                                    |                |                                              |                | ALTERED                                | REPRESENTATIVE                               |                                                       |
|--------------------------------------------------|----------------|----------------------------------------------|----------------|----------------------------------------|----------------------------------------------|-------------------------------------------------------|
| ◀ SAND SIZE                                      |                | ▶ GRAVEL SIZE                                |                | STAINED<br>STATE<br><br>(STS)<br><br>C | VISUALLY<br>FRESH<br>STATE<br>(VFS)<br><br>B | MICRO FRESH<br>STATE<br>(HAND LENS)<br>(MFS)<br><br>A |
| COMPLETELY<br>DECOMPOSED<br>STATE (CDS)<br><br>E |                | PARTLY<br>DECOMPOSED<br>STATE (PDS)<br><br>D |                |                                        |                                              |                                                       |
| PLASTIC                                          | NON<br>PLASTIC | PLASTIC                                      | NON<br>PLASTIC | COMPARE TO<br>FRESH STATE              | UNIT WEIGHT<br>RELATIVE ABSORPTION           |                                                       |

MINERAL GRAIN BONDING

| REMOLDING (1)                            | REACTION TO IMPACT                     |                                           |                                        |                                          |
|------------------------------------------|----------------------------------------|-------------------------------------------|----------------------------------------|------------------------------------------|
| MOLDABLE,<br>(FRIABLE)<br>(MBL)<br><br>E | "CRATERS"<br>(SHEARS)<br>(CQ)<br><br>D | "DENTS"<br>(COMPRESSIVE)<br>(DQ)<br><br>C | "PITS"<br>(TENSIONAL)<br>(PQ)<br><br>B | "REBOUNDS"<br>(ELASTIC)<br>(RO)<br><br>A |
| <1,000 PSI<br>(7 MPa)                    | 1,000 to 3,000 PSI<br>(7 to 21 MPa)    | 3,000 to 8,000 PSI<br>(21 to 55 MPa)      | 8,000 to 15,000 PSI<br>(55 to 103 MPa) | >15,000 PSI<br>(103 MPa)                 |

PLANAR AND LINEAR ELEMENTS

| TRANSMITS WATER                                            |    |                                                            |    | LATENT<br>PLANES OF<br>SEPARATION<br>(LPS)<br><br>C | SOLID-<br>PREFERRED<br>BREAKAGE<br>(SPB)<br><br>B | SOLID-<br>RANDOM<br>BREAKAGE<br>(SRB)<br><br>A |
|------------------------------------------------------------|----|------------------------------------------------------------|----|-----------------------------------------------------|---------------------------------------------------|------------------------------------------------|
| YES                                                        | NO | YES                                                        | NO |                                                     |                                                   |                                                |
| 3 DIMENSIONAL<br>PLANES OF<br>SEPARATION<br>(3-D)<br><br>E |    | 2 DIMENSIONAL<br>PLANES OF<br>SEPARATION<br>(2-D)<br><br>D |    |                                                     |                                                   |                                                |
| INTERLOCK                                                  |    | ATTITUDE                                                   |    |                                                     |                                                   |                                                |

UNIT WEIGHT

|                                                                                      |                                                                                            |                                                                                            |                                                                                            |                                                                                         |
|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| LESS THAN<br>130 lbs/ft <sup>3</sup><br>(2.10 Mg/m <sup>3</sup> )<br>(<130)<br><br>E | 130 to 140<br>lbs/ft <sup>3</sup><br>(2.10 to 2.25)<br>Mg/m <sup>3</sup><br>(130)<br><br>D | 140 to 150<br>lbs/ft <sup>3</sup><br>(2.25 to 2.40)<br>Mg/m <sup>3</sup><br>(140)<br><br>C | 150 to 160<br>lbs/ft <sup>3</sup><br>(2.40 to 2.55)<br>Mg/m <sup>3</sup><br>(150)<br><br>B | GREATER THAN<br>160 lbs/ft <sup>3</sup><br>(2.55 Mg/m <sup>3</sup> )<br>(>160)<br><br>A |
|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|

(1) CONSISTENCY VALUES  
 Terzaghi, K. and Peck, R. B., *Soil Mechanics in Engineering Practice*, John Wiley and Sons, Inc., 1948.



Under the URCS, the degree of weathering is restricted to "chemical weathering." The effect of weathering can be defined practically by determining the relative loss of cohesion and the reduction of unit weight. Five categories are defined: E--Completely Decomposed State; D--Partly Decomposed State; C--Stained State; B--Visually Fresh State; and A--Micro Fresh State.

EFFECT OF WEATHERING

| WEATHERED (1)                                    |                |                                              |                | ALTERED                                | REPRESENTATIVE                               |                                                       |
|--------------------------------------------------|----------------|----------------------------------------------|----------------|----------------------------------------|----------------------------------------------|-------------------------------------------------------|
| ↶ SAND SIZE                                      |                | ↷ GRAVEL SIZE                                |                | STAINED<br>STATE<br><br>(STS)<br><br>C | VISUALLY<br>FRESH<br>STATE<br>(VFS)<br><br>B | MICRO FRESH<br>STATE<br>(HAND LENS)<br>(MFS)<br><br>A |
| COMPLETELY<br>DECOMPOSED<br>STATE (CDS)<br><br>E |                | PARTLY<br>DECOMPOSED<br>STATE (PDS)<br><br>D |                |                                        |                                              |                                                       |
| PLASTIC                                          | NON<br>PLASTIC | PLASTIC                                      | NON<br>PLASTIC | COMPARE TO<br>FRESH STATE              | UNIT WEIGHT<br>RELATIVE ABSORPTION           |                                                       |

(1) CONSISTENCY VALUES

Terzaghi, K. and Peck, R. B., *Soil Mechanics in Engineering Practice*, John Wiley and Sons, Inc., 1948.

*E--Completely Decomposed State (CDS).*

The Completely Decomposed State is when the rock material is all remoldable to sand, silt, or clay, or mixtures of two or more sizes. The resulting remolded material is determined to be plastic or nonplastic, and Dry Strength, Dilatency, and Toughness tests are performed. The in-place strength is estimated by consistency values (1).

*D--Partly Decomposed State (PDS).*

The Partly Decomposed State is when the rock material is remoldable to gravel-size and larger rock fragments, with or without sand, silt, or clay mixtures. The relative percentage of rock fragments are estimated, and the material is determined to be plastic or nonplastic. The in-place strength is estimated by consistency values (1), or by size, shape, and gradation of remolded aggregate.

*C--Stained State (STS).*

The Stained State describes a condition when the rock material shows partial or complete discoloration due to oxidation, but cannot be remolded. The rock material is usually shades of yellow or brown, has a reduced unit weight, and a higher



Mineral Grain Bonding or Specimen Strength is defined as the degree of cementation or adhesion between mineral grains that defines the fundamental strength of the rock mass independent of the planar and linear elements. For purposes of classification, the "limit of moldability" is estimated at 1,000 psi (7 MPa). There are four distinct reactions to impact loading by means of a 1-lb (450-g) ball-peen hammer. The reaction is independent of intensity of blow within the limitations of the tool used and the investigators' strength. The reactions are defined as "Craters," "Dents," "Pits," and "Rebounds." Based on these reactions plus the moldability factor, five categories of specimen strength are denoted: E--Moldable; D--Craters; C--Dents; B--Pits; and A--Rebounds.

MINERAL GRAIN BONDING

| REMOLDING (1)                            | REACTION TO IMPACT                     |                                           |                                        |                                          |
|------------------------------------------|----------------------------------------|-------------------------------------------|----------------------------------------|------------------------------------------|
| MOLDABLE,<br>(FRIABLE)<br>(MBL)<br><br>E | "CRATERS"<br>(SHEARS)<br>(CQ)<br><br>D | "DENTS"<br>(COMPRESSIVE)<br>(DQ)<br><br>C | "PITS"<br>(TENSIONAL)<br>(PQ)<br><br>B | "REBOUNDS"<br>(ELASTIC)<br>(RQ)<br><br>A |
| <1,000 PSI<br>(7 MPa)                    | 1,000 to 3,000 PSI<br>(7 to 21 MPa)    | 3,000 to 8,000 PSI<br>(21 to 55 MPa)      | 8,000 to 15,000 PSI<br>(55 to 103 MPa) | >15,000 PSI<br>(103 MPa)                 |

(1) CONSISTENCY VALUES

Terzaghi, K. and Peck, R. B., *Soil Mechanics in Engineering Practice*, John Wiley and Sons, Inc., 1948.

*E--Moldable Quality (MBL).*

Moldable Quality is present when the otherwise continuous and visually similar rock material can be remolded with finger pressure. This indicates an estimated unconfined compressive strength less than 1,000 psi (7 MPa). Strength estimates are made by determining consistency values (1). In all cases, the material is examined and tested as a "soil," and a dual classification is given. Usually, the material cannot be recovered by diamond core drilling, and can be excavated by machinery.

*D--Crater Quality (CQ).*



Crater Quality rock material is, as the term implies, a reaction under point of impact producing a shearing and upthrusting of adjacent mineral grains. This category has an estimated unconfined compressive strength range from 1,000 to 3,000 psi (7 to 21 MPa). Usually, The rock material can be recovered during rock core drilling operations, has



UNIFIED ROCK CLASSIFICATION SYSTEM (URCS)  
ROCK MASS STRENGTH ESTIMATE - BASIC ELEMENTS

| EFFECT OF WEATHERING              |                               |                        |                                 |                                     |
|-----------------------------------|-------------------------------|------------------------|---------------------------------|-------------------------------------|
| WEATHERED (1)                     |                               | ALTERED                | REPRESENTATIVE                  |                                     |
| ← SAND SIZE                       | → GRAVEL SIZE                 | STAINED STATE (STS)    | VISUALLY FRESH STATE (VFS)      | MICRO FRESH STATE (HAND LENS) (MFS) |
| COMPLETELY DECOMPOSED STATE (CDS) | PARTLY DECOMPOSED STATE (PDS) | C                      | B                               | A                                   |
| E                                 | D                             |                        |                                 |                                     |
| PLASTIC                           | NON PLASTIC                   | COMPARE TO FRESH STATE | UNIT WEIGHT RELATIVE ABSORPTION |                                     |

| MINERAL GRAIN BONDING     |                                  |                                   |                                     |                           |
|---------------------------|----------------------------------|-----------------------------------|-------------------------------------|---------------------------|
| REMOLDING (1)             | REACTION TO IMPACT               |                                   |                                     |                           |
| HOLDABLE, (FRIABLE) (MBL) | "CRATERS" (SHEARS) (CQ)          | "DENTS" (COMPRESSIVE) (DQ)        | "PITS" (TENSIONAL) (PQ)             | "REBOUNDS" (ELASTIC) (RO) |
| E                         | D                                | C                                 | B                                   | A                         |
| <1,000 PSI (7 MPa)        | 1,000 to 3,000 PSI (7 to 21 MPa) | 3,000 to 8,000 PSI (21 to 55 MPa) | 8,000 to 15,000 PSI (55 to 103 MPa) | >15,000 PSI (103 MPa)     |

| PLANAR AND LINEAR ELEMENTS               |                                          |                                   |                                |
|------------------------------------------|------------------------------------------|-----------------------------------|--------------------------------|
| TRANSMITS WATER                          |                                          | LATENT PLANES OF SEPARATION (LPS) | SOLID-PREFERRED BREAKAGE (SPB) |
| YES                                      | NO                                       |                                   |                                |
| 3 DIMENSIONAL PLANES OF SEPARATION (3-D) | 2 DIMENSIONAL PLANES OF SEPARATION (2-D) |                                   | SOLID-RANDOM BREAKAGE (SRB)    |
| E                                        | D                                        | C                                 | B                              |
| INTERLOCK                                | ATTITUDE                                 |                                   | A                              |

| UNIT WEIGHT                                                        |                                                                        |                                                                        |                                                                        |                                                                       |
|--------------------------------------------------------------------|------------------------------------------------------------------------|------------------------------------------------------------------------|------------------------------------------------------------------------|-----------------------------------------------------------------------|
| LESS THAN 130 lbs/ft <sup>3</sup> (2.10 Mg/m <sup>3</sup> ) (<130) | 130 to 140 lbs/ft <sup>3</sup> (2.10 to 2.25 Mg/m <sup>3</sup> ) (130) | 140 to 150 lbs/ft <sup>3</sup> (2.25 to 2.40 Mg/m <sup>3</sup> ) (140) | 150 to 160 lbs/ft <sup>3</sup> (2.40 to 2.55 Mg/m <sup>3</sup> ) (150) | GREATER THAN 160 lbs/ft <sup>3</sup> (2.55 Mg/m <sup>3</sup> ) (>160) |
| E                                                                  | D                                                                      | C                                                                      | B                                                                      | A                                                                     |

(1) CONSISTENCY VALUES  
Terzaghi, K. and Peck, R. B., *Soil Mechanics in Engineering Practice*, John Wiley and Sons, Inc., 1948.

CUT ALONG THIS LINE

SYMBOLS AND NOTATIONS

The letter design symbols of the four major element classes are grouped together in a four-letter notation that can be read at a glance when placed on maps, sections, or on drilling logs. The four letters are in caps and are underlined. The letter "A" denotes that the least design evaluation is required, while "E" denotes the most design evaluation is required. "O" in sequence means "no determination made." A lower-case "e" after a letter indicates "estimated value."

FIELD NOTATION

In the field the notation includes both the letter symbol and the abbreviated basis written under the letter. For example:

The classification: BCAD

Field notebook: B C A D  
VFS DQ SRB 130

Explanation: B--Visual fresh state; C--Dents with hammer blow; A--Solid with random breakage; and D--unit weight 130 to 140 pcf (2.10 to 2.25 Mg/m<sup>3</sup>)

The design values can then be established for this material for the intended purpose.

Notes: 1. AAAA requires the least design evaluation. EEEE requires the most design evaluation.

Some combinations do *not* occur, for example: completely Decomposed State, and Greater than 15,000 psi (103 MPa); Solid with random breakage, and Greater than 160 pcf (2.55 Mg/m<sup>3</sup>) EAAA.

2. Design values of the four major elements are not equivalent even though the same letter notation might apply.

CUT ALONG THIS LINE



## INVITATION TO READERS OF *FIELD NOTES*

Every reader is a potential author of an article for *Field Notes*. If you have a news item or short article you would like to share with Service engineers, we invite you to send it for publication in *Field Notes*.

Material submitted to the Washington Office for publication should be reviewed by the respective Regional Office to see that the information is current, timely, technically accurate, informative, and of interest to Forest Service Engineers (FSM 7113). The length of material submitted may vary from several short sentences to several typewritten pages; however, short articles or news items are preferred. All material submitted to the Washington Office should be typed double-spaced, and, ideally, all illustrations should be original drawings, glossy prints, or negatives.

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