

**ENGINEERING
TECHNICAL
INFORMATION
SYSTEM**

FIELD NOTES • TECHNICAL REPORTS • TEXTS
DATA RETRIEVAL • CURRENT AWARENESS

Field Notes

Volume 5 Number 11 November 1973

New Developments in Concrete

**Status of Federal Dam Safety
Inspections**

**Washington Office Division of Engineering
News**



FOREST SERVICE • U.S. DEPARTMENT OF AGRICULTURE

ENGINEERING FIELD NOTES

This publication is a monthly newsletter published to exchange engineering information and ideas of a technical or administrative nature among Forest Service personnel. The text in this publication represents the personal opinions of the respective author and must not be construed as recommended or approved procedures, mandatory instructions, or policy, except by FSM references.

This publication is not intended to be exclusively for engineers. However, because of the type of material in the publication, all engineers and engineering technicians should read each issue.

This publication is distributed from the Washington Office directly to all Regional, Station, and Area Headquarters. If you are not now receiving a copy and would like one, ask your Office Manager or the Regional Information Coordinator to increase the number of copies sent to your office. Use Form 7100-60 for this purpose. Copies of back issues are also available from the Washington Office and can be ordered on Form 7100-60.

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 engineers Service-wide (FSM 7113). The length of material submitted may vary from several sentences to several typewritten pages. However, short articles or news items are preferred. The Washington Office will edit for grammar only. All material submitted to the Washington Office should be typed double-spaced, and all illustrations should be original drawings or glossy black and white photos.

Each Region has an Information Coordinator to whom field personnel should submit both questions and material for publication. The Coordinators are:

R-1 Bob Hinshaw	R-6 Kjell Bakke
R-2 Allen Groven	R-8 Ernest Quinn
R-3 Dan Roper	R-9 Ron Pokrandt
R-4 Fleet Stanton	R-10 Bill Vischer
R-5 Jim McCoy	WD Al Colley

Coordinators should direct questions concerning format, editing, publishing dates, etc., to Fran Owsley, Editor, Division of Engineering, Forest Service, USDA, Washington, D. C. 20250.

This monthly newsletter is published for distribution to employees of the U. S. Department of Agriculture--Forest Service and its retirees only. The Department of Agriculture assumes no responsibility for the interpretation or use of this information by other than its own employees.

The use of trade, firm, or corporation names is for the information and convenience of the reader. Such use does not constitute an official evaluation, conclusion, recommendation, endorsement, or approval of any product or service to the exclusion of others which may be suitable.

F I E L D N O T E S

NEW DEVELOPMENTS IN CONCRETE

By Maximil Grietens
Structural Engineer, Region 5

At the recent convention of the American Concrete Institute at Miami, Florida, the presentations of papers on "Use of Expansive Cement," "Polymers in Concrete," and "Fibrous Concrete" were received with much interest by the attending Structural Engineers. These developments in concrete may be worth considering in Forest Service structures. These topics are discussed in the balance of this article.

EXPANSIVE CEMENT CONCRETES

Most Engineers have suffered the unpleasant experience of having some sort of cracking occur on concrete jobs. There are many types of concrete cracks, such as structural cracks, settlement cracks, cracks resulting from temperature changes, plastic drainage cracks, and drying shrinkage cracks. Of these various types, drying shrinkage cracks are the most common and troublesome. All concrete structures contract as the temperature falls to the ambient value following the rise due to the evolution of the heat of hydration. If this contraction is restrained, it follows that tensile stresses are induced which can cause cracking of the concrete. Much has been done in the field of research and development toward elimination and/or control of drying shrinkage cracks. This has helped to a degree, but it is not adequate because standard Portland cement concrete always undergoes a negative volume change upon drying.

In a discussion of expansive cement concretes, it was shown that a simple method of compensating for stresses due to drying shrinkage makes it possible to produce concrete virtually free of this type of cracking. This method involves using a modified Portland cement. Such a cement gives promise of controlling shrinkage during setting of the concrete, such as in restrained elements reinforced with minimum shrinkage steel required by code. The principal property of such cements is that the expansion

induced in the plastic concrete while setting is designed to almost offset the normal moisture shrinkage. Under correct usage, the distance between joints can sometimes be tripled without increasing the level of shrinkage cracking. Expansive cement has the ability to eliminate or reduce drying shrinkage cracks if proper design, construction and quality control procedures are adhered to. It is not an additive, but a finished cement produced in a cement plant in the same manner as standard Portland cement. In other words, it is a cement which, when mixed with water, forms a paste that during and after setting and hardening, increases in volume and compensates the expected amount of shrinkage strain.

Results of studies on prestressed concrete, reinforced concrete pipes and continuously reinforced concrete pavements made with expansive cement concrete were discussed. It was demonstrated that the use of this kind of cement in continuously reinforced and prestressed concrete pavements can be effective not only in compensating drying shrinkage of concrete pavements but also to the restraint of expansion by subgrade friction and reinforcement, if the expansion of concrete due to expansive cement existed sufficiently for a long period. The application of expansive cement to concrete pavements was widely examined experimentally in the laboratory and in field work in Japan.

Expansive cement in this country has been commercially produced since 1963. In 1967 the annual production passed the 200,000-ton mark and since then, upward growth has continued. This cement is manufactured by a number of leading cement producers throughout the United States. Modern development of expansive cement started in France in 1940. The original concept of expansive cement was established over 80 years ago.

POLYMERS IN CONCRETE

During the last few years, much research has been done on the polymer-impregnated concrete. There are several different kinds of polymers — named according to its source, whenever it is derived from one single original or hypothetical monomer, it is also named according to its structure. There is still a general need for more data on almost every aspect of properties and behavior. Nevertheless, the future of this concrete is encouraging. Three materials being investigated are:

- Polymer-impregnated concrete — precast Portland cement concrete impregnated by a monomer system which is subsequently polymerized in-situ.
- Polymer-cement concrete — monomer is added during mixing of Portland cement, water, and aggregate; followed by polymerization.

- Polymer-concrete — a composite formed by polymerizing a monomer and an aggregate mixture.

Investigations indicate that the most successful concrete-polymer material for construction is polymer-impregnated concrete. Filling the pores of hardened concrete with a liquid monomer and polymerizing the monomer in-situ produces a composite material having many properties substantially different from those of the original concrete. Compared to conventional concrete, polymer-impregnated concrete shows remarkable improvements in strength, durability and corrosion resistance, and it shows reduction in permeability and volume change. Compression strength as high as 32,400 psi (2280 kg/sq. cm) has been measured. Work to date has indicated that an increase in compressive strength can be obtained with both high- and low-quality concretes.

Preliminary design studies using computer-coded finite element analysis were made to determine the feasibility of using concrete-polymer material for precast bridge decks and breakaway lamp posts. Based on the limited data on properties, both applications appear attractive. Additional data under static and dynamic test conditions are required before a detailed structural design and cost estimate can be made.

STEEL FIBER-REINFORCED CONCRETE

One of the major disadvantages of conventional concrete is its inherently low tensile strength. The tensile strength of concrete can be significantly increased through the use of short, small-diameter, steel fibers randomly distributed in the mix. The idea that steel fibers could provide improved tensile strength in concrete came from existing fracture mechanics concepts. Concrete is a brittle material which, as normally prepared, contains numerous flaws and disparities. These existing flaws act as stress concentration points and greatly lower the amount of stress that would otherwise be required to fail the material. The larger the flaws, the lower will be the stress intensity at the propagation front of existing flaws, thereby increasing the applied stress necessary to propagate the flaw. For many practical applications, the most commonly used fibers range from 0.01 to 0.02 inch in diameter and 0.75 to 1.0 inch in length. Aggregates up to 0.375 inch have been used without undue sacrifice in properties. Typical fiber additions range from 0.5 to 2.0 percent by volume (180 to 265 pounds per cubic yard).

It is to be stressed that fiber-reinforced concrete is a unique construction material — it is not just another type of reinforced concrete. Through the use of random dispersions of short steel fibers, a material results that behaves more as a ductile metal than as concrete. Other properties and characteristics of mortar and concrete which are generally improved through steel fiber additions include thermal stress and thermal shock resistance, impact strength, abrasion resistance, shear strength, and spalling resistance.

Fibrous concrete has been prepared in both batch-type and central mix-type operations. Once delivered to the site, the concrete is handled and finished in about the same manner as conventional concrete. When used with reinforcement steel, the amount of steel will be less than that required for normal reinforcement. It is important to note that fibrous concrete is not reinforced concrete in the sense of the word.

One of the best applications for fibrous concrete could be bridge decking. The material seems to be ideal for resurfacing not only concrete decks but also timber bridge decks. Two-inch-deep overlay on an old wooden deck was used successfully. It is also believed that this concrete could make possible the use of precast bridge-deck slabs for use in new structures and for repair.

Although the "in-place" costs for fibrous concrete road surfaces and bridge decks may never be less than those of the conventional materials in use today, it is relatively safe to say that the reduced maintenance and the longer life which can be expected could justify initial costs that are higher than those for the more conventional materials.

Fibrous concrete provides the same design flexibility and fluidity that the architect expects from ordinary concrete plus some other important benefits. Structures can be designed that take advantage of the high flexural strength of fibrous concrete so as to permit the use of much thinner sections than can be tolerated with conventional reinforced concrete. The use of fibrous concrete for architectural and thin-shell applications is encouraging.

On an equal volume or weight basis, fibrous concrete is more costly than conventional concrete and the cost differential is primarily a function of the cost of the metal fiber. However, fibrous concrete has different properties and usually will permit a reduction in cross section.

Concrete containing steel fibers has been assigned the trade name of Wirand concrete by the Battelle Development Corporation, Columbus, Ohio, which owns the patents on the material in the United States and other countries.

Finally, it should be mentioned that the application of this approach to concrete or mortar is by no means new. In 1910 Harry Franklin Porter from Connecticut claimed some dramatic increases in the physical properties of concrete by the addition of cut nails and spikes to the mixes.



STATUS OF FEDERAL DAM SAFETY INSPECTIONS

By Larry Hendrickson
Dams Engineer, WO Division of Engineering

Public Law 92-367, the National Dam Safety Act, was passed by Congress with the objective of reducing the risk of dam failures. This legislation was passed without hearings in two days because of the recent tragedies in Rapid City, South Dakota, and Buffalo Creek, West Virginia. The Forest Service is deeply involved with the administration of this act because of the large number of dams on the National Forests. A preliminary estimate by this office is that there are 600 to 800 dams under Forest Service jurisdiction which qualify as needing inspection under PL 92-367. We are currently making a dam inventory report for the Corps of Engineers, which will give an accurate count. The current status of this inventory will be explained below under the section on "Activity to Date."

To bring this legislation into perspective as to its application to the National Forest system, it should be mentioned that one of the dam failures which influenced the passage of the act was a structure under the jurisdiction of the Forest Service. Congress has also given direction to Federal agencies in the 1973 Interior and Related Agencies Appropriation bill which reads:

Agencies for which funds are provided in this bill are directed to investigate the condition of all dams and other water storage and control structures on lands under their management and jurisdiction to insure their safety, to review the criteria and standards for construction and inspection of such structures under their jurisdiction, and to report their findings to the Committee within one year.

REQUIREMENTS OF THE NATIONAL DAM SAFETY ACT¹

Public Law 92-367 dated August 8, 1972, the National Dam Safety Act, authorizes the Secretary of the Army to undertake a national program of inspection of dams. A dam

¹Note: This section is an abridgement of the National Dam Safety Act. Refer to the parent material for legal purposes or a more complete wording.

is defined as a man-made barrier which impounds or diverts water which is (1) twenty-five feet or more in height from the natural bed of the stream or water course (measured at the downstream toe to the maximum water storage elevation), or (2) has an impounding capacity at maximum water surface elevation of fifty acre-feet or more. Excluded is any barrier less than six feet in height or which stores less than fifteen acre-feet.

The Secretary of the Army, acting through the Corps of Engineers, is directed to carry out a national program of inspection of dams. All dams are to be inspected except:

- Dams under the authority of the Bureau of Reclamation, the Tennessee Valley Authority, and the International Boundary and Water Commission.
- Dams which have been constructed pursuant to licenses issued by the Federal Power Commission.
- Dams inspected within the 12 months prior to the enactment of the Act by a State agency and which the Governor of such State requests it be excluded.
- Dams which the Secretary of the Army determines that they do not pose any threat to human life or property.

As soon as practicable the Governor of the State in which the dam is located is to be notified of the results of the inspections performed.

The Act further requires the Secretary of the Army to report to Congress, on or before July 1, 1974, on the activities under the Act including (1) an inventory of all dams in the United States, (2) a review of each inspection made including recommendations and follow-up action, and (3) recommendations for a comprehensive national program for the inspection and regulation of dams. He is also to make recommendations as to the respective responsibilities which should be assumed by Federal, State, and local governments and by public and private interests.

ACTIVITY TO DATE

The Army Corps of Engineers has prepared preliminary review *Standards for Safety Inspections of Dams*. These standards have been reviewed and commented on by interested agencies including the Forest Service. The Forest Service comments were combined with those from the Soil Conservation Service to form the Secretary of Agriculture's reply.

The proposed standards (copies were sent to all Regions) consist of a two-phase inspection procedure. The objective of Phase I inspection is to "establish conclusively whether or not conditions exist which constitute a danger to human life or property or, in lieu thereof, what additional investigations or inspections are necessary to complete the safety evaluation." This inspection will consist of a review of all engineering data relative to the design, construction and operation of the dam and appurtenant structures. Also included in the Phase I investigation is a detailed systematic visual inspection of features relating to the structure stability and adequacy of the operation of the installation. Phase II inspections will be performed when the results of the Phase I inspection indicates a need for additional investigation because of (1) age, condition, and size of the dam, or (2) where engineering data relating to the design and construction are lacking or questionable. The Phase II inspection can become very complex and expensive. It will include items such as stability analysis, materials testing, foundation explorations, and additional hydrologic analyses based upon updated storm estimates.

A second major activity currently being conducted is the preparation of a national inventory of all dams in the United States that fit the definition given in the Act. For Federally owned or regulated dams, inventory data is being obtained from the owner-agency. Information in a standardized format has been requested from the Forest Service. This office has met with Corps of Engineers representatives and it has been agreed that data in the present Forest Service inventory is acceptable, provided that it is furnished in the required standard form. It was also determined that computer cards would be acceptable rather than written information on the forms prepared by the Corps of Engineers.

Currently, the only major activity being instigated by the Dam Safety Act is the actual preparation of the dam inventory. This office, working in conjunction with Region 4, will prepare a computer program which will punch the required cards in the correct format. This program will be compatible with the C.D.C. computer and with existing magnetic tape dam inventory records. The plan at this time is to forward the program to those Regions with C.D.C. computers to prepare the cards. The cards would then be sent to this office for transmittal to the Corps of Engineers.

It is not anticipated, under the terms of this Act, that any actual dam inspections will be required this Fiscal Year. A paragraph quoted from a letter to the Chief of the Forest Service, dated May 2, 1973, written by the Army Corps of Engineers explains the program for Fiscal Year 1974:

The program scope as presently planned consists of preparing an inventory of all Federal and non-Federal dams, as defined by the Act, and formulating recommendations to the Congress for a comprehensive national dam safety program, including the respective responsibilities which should be assumed by Federal, State and local governments and by public and private interests.

The results of these activities will be reported to the Congress by July 1, 1974.

LONG RANGE ACTIVITIES

It is anticipated that the Forest Service will be deeply involved with the safety inspection of all dams on Forest Service-managed lands, except for those under jurisdiction of other Federal agencies or commissions. Currently, the Corps of Engineers is charged with instigating the inspection program. However, on Federal lands the managing agency will be given the responsibility for conducting the inspections. At this time, we do not know the exact recommendations the Corps of Engineers will be making to Congress – as mentioned in the foregoing section. We will be working closely with the Corps in order to insure recognition of Forest Service needs and constraints. As an example of the special requirements in the Forest Service, the Secretary of Agriculture made the following statement in his reply to the proposed inspection standards:

Phase I inspections require the collection of a considerable volume of data for each dam. Many of the Forest Service dams are old and the data required is not available. As we understand your proposal, such data would have to be collected in a Phase II inspection. This would create a tremendous work load for our personnel and seriously hamper our ongoing programs. To comply with the proposed investigations and the intent of the Act will require increased financing that cannot be absorbed by our existing appropriations. We note that the States are to be reimbursed for their share of this program. We believe the same principle should apply to the Department of Agriculture.

It will require some time for Congress to act on the Corps of Engineers' recommendations. Consequently, it will be the summer of 1975 before a large-scale inspection effort will affect the Forest Service.

The WO Division of Engineering will postpone the Service-wide Dams Engineering Workshop scheduled for the spring of 1974 until the following year in order to be more timely in regard to congressional activity in this area.

List of Previous Washington Office Correspondence:

Date	File Number	Description
July 14, 1972	7570	Notifies Regions of dam inspection instructions contained in 1973 Interior Appropriations bill. Instructs Regions to inspect all dams and water storage facilities.
October 24, 1972	7570 (7100)	Transmits Corps of Engineers discussion of proposed dam safety legislation presented at the Western State Engineers Meeting.
December 7, 1972	7570 (7100)	Transmits copies of preliminary Standards for Safety Inspections of Dams. Requests Regional comments.
March 1, 1973	7570	Furnishes each Region a copy of the USDA formal response to the preliminary standards.
August 27, 1973	7570	Furnishes each Region a copy of Forest Service correspondence concerning preparation of the national dam inventory.

● ● ● ● ● ● ● ● ● ●

WASHINGTON OFFICE DIVISION OF ENGINEERING NEWS

TECHNOLOGICAL IMPROVEMENTS

Heyward T. Taylor
Assistant Director

ED&T Team to Pakistan. The Agency for International Development (AID) requested the Secretary of Agriculture to send Forest Service equipment and support personnel to Pakistan for a spray operation to prevent infestation of rice by stem borers. The Missoula Equipment Development Center (MEDC) had two nitrogen pressurized spray systems available. Ernie Amundsen, MEDC, headed the four-man team which included Lynn Marsalis, Pest Control Planner, Tony Jasumback, Mechanical Engineer, and John Cavill, Engineering Technician. The team was augmented by Jim Larkin, a pilot from Region 4. They acquired supplies, tools, and equipment needed to mount and operate the spray systems and were flown by USAF to Lahore, Pakistan.

The spray systems were mounted in two USAF C-47 airplanes. After testing and calibrating the equipment, the initial sortie was flown on September 13 in the Lahore area of Punjab Province. The operation was then moved south to Nawabshaw in Sind Province. Twenty-nine sorties were flown and 100,000 acres were sprayed during the next 8 days completing the operation on schedule. From the first call made to the Forest Service to the completed operation, the total time was one month. Boone Richardson, WO, coordinated actions with WO Divisions, Deputy Chiefs and the Chief. Ernie Amundsen coordinated actions of the Development Center staff and the Regional Office in Missoula so as to meet the specific requests from the Foreign Disaster Relief Coordination Center of AID.



CONSULTATION AND STANDARDS

C. R. Weller
Assistant Director

Highway Structures

Glued-Laminated Timber Bridge Decks. The most recent improvement in timber bridge design is the vertically glued-laminated (glu-lam) panel deck. The Forest Products Laboratory (FPL) in Madison, Wisconsin, has developed a design method which considers the glu-lam deck as an orthotropic plate. Continuity between panels is provided with a steel dowel connector system. The panels are spiked to the stringers through holes drilled before treatment. The glu-lam deck's superiority over the conventional nail-lam deck has been demonstrated both in the Lab and in the field. The FPL report covering research and design procedures were distributed in October, 1973.

Alaska Bridges. Forest Service bridges, recently constructed on the South Tongass National Forest in Alaska, are receiving national attention in the trade magazines and in advertising brochures. The single-span, double-lane structures are designed for U80 logging loads. The design configuration is longitudinal timber decking supported by a floor beam-structural plate girder system. High-strength, weathering steel was used to reduce shipping, field labor, and maintenance costs. The structures were designed by the Region 15 bridge unit, Federal Highway Administration. An informative brochure can be obtained from your local United States Steel representative.

A Report and Viewpoint on "The Architect, The Engineer, and OSHA." On June 25 and 26, a national conference on the Occupational Safety and Health Act (OSHA) was held in Washington, D. C. The conference was titled "The Architect, The Engineer, and OSHA," and was cosponsored by the American Society of Civil Engineers, the Consulting Engineers Council of the U. S., the American Institute of Architects, and the National Society of Professional Engineers.

The purpose of the conference was to acquaint design professionals (architects and engineers) with the direct and indirect responsibilities required by OSHA. The program was very comprehensive and emphasized that the OSHA regulations affect the working life of every design and construction professional, and as such, are pertinent to the Forest Service.

OPERATIONS

Harold L. Strickland
Assistant Director

Geometronics – USGS Announces New Product. Slope mapping is a recent addition to the U. S. Geological Survey's line of maps. This addition was made possible by the development of the semiautomatic photomechanical technique that generates slope information directly from existing contour drawings. The technique normally generates an individual slope zone for an entire quadrangle in a single operation. Figure 1 is a monochrome print of a slope map showing four slope zones. This is the maximum number of slopes that can be easily discerned without concentrated study. USGS is investigating a five slope zone print, but still has reservations as to the ease of visually separating the different zones. Although Figure 1 is in shades of gray, the Geological Survey produces these slope maps representing each slope zone with a different color.

Cost estimates are influenced by many factors, such as:

- The presence of supplement contours or dual interval contours that require special treatment.
- The number of zones to be generated.
- The preparation of map materials at other than publication scale.
- The preparation of additional map drawing reproducibles such as the planimetric and drainage drawings as part of the slope map.
- The number of required composites, color proofs, etc.

With these thoughts in mind, and excluding printing costs, a ball park estimate for preparing a single slope zone drawing for an entire quadrangle is approximately \$125, and for a four slope zone drawing approximately \$450. Also the planning process requires a minimum of three months lead time.

These estimates are for planning purposes only. In order to get a more precise cost estimate and tentative production schedule, the following information is needed:

- Name of the quadrangle(s).
- The identification of the slope zones to be generated.
- The final map scale.
- The proposed method of reproduction.

The USGS asked that all requests for slope mapping and/or estimates be sent to:

Robert H. Lyddan, Chief
Topographic Division
U. S. Geological Survey
Department of the Interior
Washington, D. C. 20240

A copy of the request is to be sent to Washington Office Geometronics to assist in analyzing map uses and future program requirements.

