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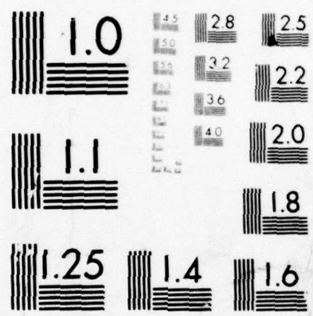

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ENGINEERING AND SCIENTIFIC RESEARCH AT WES

Miscellaneous Paper 0-72-1 September 1972

NEW CONCEPT FOR ROAD CONSTRUCTION,

by S. L. Webster, Soils and Pavements Laboratory

Military roads require high-strength foundation materials to support the heavy loads of supply and tactical vehicles. Materials commonly used for this purpose are granular materials from natural deposits, crushed rock, or, in some cases, stabilized in-place soils. In most instances, obtaining material and producing a foundation layer using conventional techniques involve much work and high cost.

A new concept of road construction for military applications now being investigated by engineers at the Waterways Experiment Station (WES) involves wrapping compacted native fine-grained soil in plastic and asphalt-plastic membranes to form the foundation layer. As long as the enclosed soil remains protected from water intrusion, it will support military cargo vehicle traffic. This process, called membrane-enveloped soil layer (MESL) construction (fig. 1), may also be adapted to airfield construction.

The MESL road system consists of a subgrade upon which a foundation layer of compacted soil (constructed from natural subgrade soil or locally available soil) lies between lower and upper waterproof membranes which are joined and sealed along the edges, forming a waterproof encapsulated soil system. The upper membrane can support limited rubber-tired traffic. The MESL can serve as a base course and pavement surface on secondary roads, but

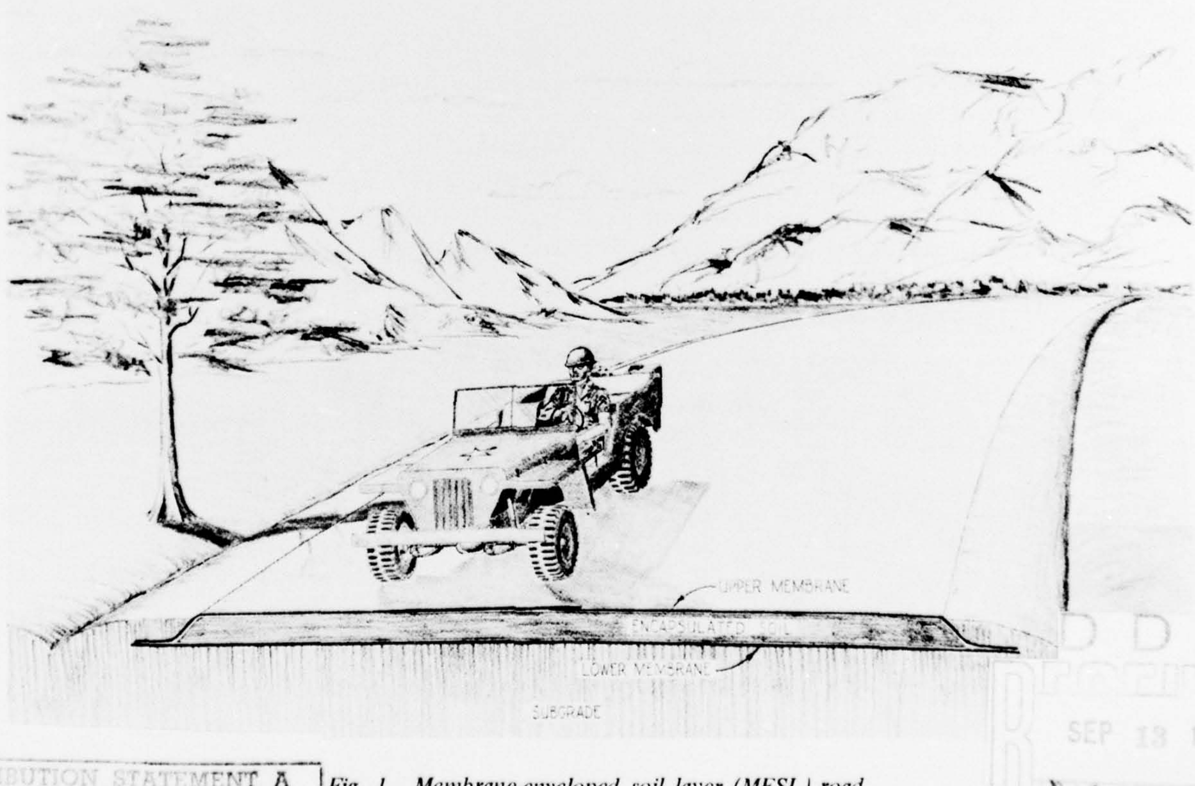

Fig. 1. Membrane-enveloped soil layer (MESL) road

Fig. 2. Installing lower membrane

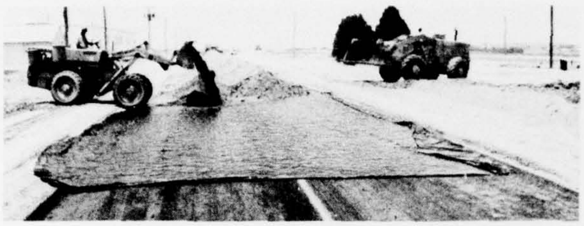

Fig. 3. Placing soil on lower membrane

Fig. 4. Installing upper membrane

on a primary road will require an overlying pavement.

The soil enveloped must be compacted to a sufficient density to prevent excessive consolidation during traffic operations. Tests have shown that a full 12-in. lift of soil, compacted to 95 percent of AASHO T-180, will support a 5-ton, 6x6 military cargo truck loaded to its maximum weight for highway travel. The water content of the soil to be wrapped should be at or preferably below optimum moisture during construction.

To test the MESL concept, WES sponsored the construction of a 1/2-mile road at Fort Hood, Texas. The two-lane road was constructed in less than a week in June 1972 by personnel of the Director of Facilities Engineering at Fort Hood and under the general supervision of personnel from the General Engineering Support Branch of the Soils and Pavements Laboratory at WES.

Construction began with a scraper removing the top 10 in. of the soil to be used to form the foundation layer. A road grader smoothed the subgrade surface, and a light coat of emulsified asphalt was sprayed on the subgrade. Polyethylene sheets, each 32 by 100 ft, were spread by hand on the subgrade. Due to the gusty winds at Fort Hood, several men were needed for this operation (fig. 2).

Front-end loaders placed the soil on the lower membrane (fig. 3). After compaction to required specifications, the soil layer received a spray coating of rapid-setting emulsified asphalt. The surface layer was placed in one operation using an asphalt distributor with a simple laying yoke for unrolling the fabric (fig. 4). The fabric, made of polypropylene fibers that are surface fused to one another to provide omnidirectional strength, weighed about 4 oz per sq yd. Each roll, 15-1/2 ft wide and 300 ft long, weighed approximately 140 lb.

A final application of asphalt was sprayed on the polypropylene. The surface was then blotted with sand completing the MESL base course.

Since the Fort Hood road will be a primary road supporting heavy traffic of both military and civilian vehicles, a 2-in. surface of hot-mix asphalt pavement was placed over the MESL. Success with the new road (fig. 5) will increase the military's ability to rapidly construct roads in areas where conventional foundation materials are expensive or difficult to procure.

Fig. 5. Completed road

AUTOMATIC FIELD DATA COLLECTION SYSTEM, *by A. N. Williamson, and L. E. Link, Jr., Mobility and Environmental Systems Laboratory*

Engineers and scientists working in environmental research, resource planning, urban renewal, environmental protection, and other related fields are keenly aware of a critical shortage of data of the type and quantity required to establish environmental baseline conditions, to compute environmental stresses resulting from activities of man, and to drive computer models for predicting the environmental impact of construction or management activities. These operations require quantitative data describing a variety of environmental parameters. In many cases the data must be taken at many different locations at regular intervals over an extended period of time. The data must be reduced to a convenient form and presented in a useful format. Unfortunately, if the data are collected and recorded manually, the costs for data acquisition, reduction, and presentation are substantial and in many cases prohibitive.

The Waterways Experiment Station (WES) has developed a data collection system to automatically: (a) collect and record data at regular intervals over a period of time; (b) sort and store the enormous volume of resulting data in a manner that permits easy retrieval; and (c) present the data in useful forms as conditions require. The system has been found to substantially reduce data collection errors and costs that normally result when conventional data collection techniques are employed.

The heart of the data collection system is an Automatic Field Data Recorder (AFDR). The designers incorporated into the system features that facilitate its use by nontechnically trained field personnel in even the most adverse field conditions. Prominent among these features are simplicity of setup and operation, reliability under anticipated field operating conditions, and ease of maintenance.

The AFDR is designed to accept analog voltage outputs from as many as 20 different sources, convert these voltages to binary coded decimal (i.e. to digital form), and record the information serially on magnetic tape at prescribed intervals over a period of time. In addition, the recorder can also accept the output from an optional hand-held control unit, thus permitting data to be manually entered on the magnetic tape.

The recorder can be interfaced with any type of sensor whose output signal can be conditioned to provide a dc signal to the recorder in the range of 0 to 100 mv with 100 percent overranging. Thus, it is possible to use with the recorder a number of different types of sensors (fig. 1), such as thermistors, solar radiometers, rain gages, wind speed and wind direction sensors, and water pH, conductivity, depth, and dissolved oxygen probes. Once a configuration of sensors has been established, appropriate signal conditioning interfaces are selected to convert the output from each sensor to a voltage that varies between 0 and 100 mv. Each sensor is then assigned to a specific AFDR channel and coupled through its respective interface to that channel. The AFDR can then be placed into operation.

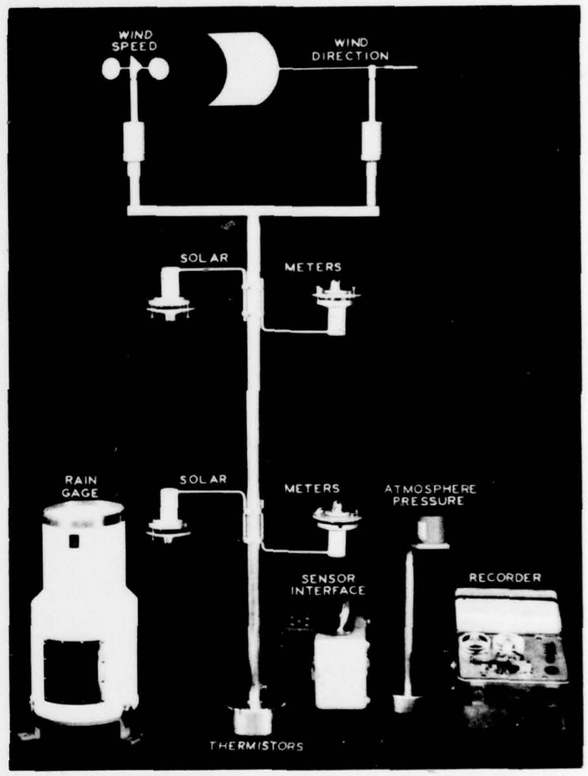

Fig. 1. Tape recorder with typical group of sensors

The AFDR is powered by an internal 12-volt rechargeable battery capable of supplying the power required to sample 20 channels at 15-min intervals for a period of 1 to 3 weeks, depending on the sensor interface power requirements.

During the data reduction process, steps are taken to check the recorded data for errors, convert the data from millivolts to more familiar and usable terms, and store the data in an organized manner to facilitate easy retrieval of all or parts of the data as requirements dictate.

Each sensor used with the AFDR is calibrated to establish the relationship between its output voltages and the stimuli producing these voltages. The calibration curves that result are placed in computer storage for use in converting the voltages to more useful terms (e.g. thermistor output converted from millivolts to ^{o}C, etc.). Separation of data recorded on tape according to sensor type is therefore required to "match" each sensor input with the proper calibration curve.

Flexibility in mixing sensors of different types and utilizing new types of sensors as they become available is achieved by a set of computer programs that automatically search each record and separate the words in each record according to sensor type, match the words with the appropriate calibration curve, make the conversion from millivolts, and store the data in a file. The operation of the computer programs can be easily changed each time the sensor configuration is changed by changing the input variables.

A number of options are available for presentation of the data. For diagnostic purposes, a strip record can be printed directly from the AFDR magnetic tape. Secondly, a data table can be generated to check for data errors or to accompany x-y plots. Finally, data from any selected channel or group of channels can be automatically plotted as a function of data in any other channel or as a function of time.

The applications of this system are limited only by the user's imagination. Past applications of the AFDR system at the WES include:

a. Measurement of diurnal variations in the temperature distribution of specific terrain features to determine the optimum time to conduct an airborne thermal infrared remote sensing survey.
b. Collection of ground truth data during airborne remote sensing surveys.
c. Compilation of detailed meteorological data in support of environmental research programs.
d. Compilation of basic environmental data in the development of quantitative terrain simulation models.

More specific applications of the system might be to monitor the temperature of curing concrete at various depths in a highway, dam, or other such structure, or to obtain enough simultaneous water temperature measurements in an estuary to plot in 3-D a thermal anomaly from a power plant.

Engineering and Scientific Research at WES is published by the Waterways Experiment Station (WES), Vicksburg, Mississippi, to acquaint U. S. Government agencies and the research community in general with the many-faceted types of engineering and scientific activities currently being conducted at WES. Inquiries with regard to any of the reported specific subjects will be welcomed, and should be addressed to respective authors, U. S. Army Engineer Waterways Experiment Station, P. O. Box 631, Vicksburg, Mississippi 39180.