TRANSPORTATION
RESEARCH
CENTER

TRANSPORTATION RESEARCH CENTER

SCHOOL OF ENGINEERING
UNIVERSITY OF ALASKA FAIRBANKS

OVERVIEW

by

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INSTITUTE OF NORTHERN ENGINEERING

UNIVERSITY OF ALASKA FAIRBANKS

FAIRBANKS, ALASKA 99775

THE INSTITUTE OF NORTHERN ENGINEERING TRANSPORTATION RESEARCH CENTER - A WINNING TEAM

Overview

The Transportation Research Center (TRC) was established in 1983 as part of the Institute of Northern Engineering at the University of Alaska Fairbanks for the purpose of providing the lead in Alaskan transportation education and research. The role of transportation in promoting the economic growth of the State is enormous. The development of Alaska's vast natural resources including mining, gas, oil, and timber, in addition to tourism and trade necessitates upgrading and maintaining our transportation infrastructure. However, nature and geography pose unique problems to Alaska. Challenging problems associated with multimodal transportation (air, land, and sea), cost-effective pavements and airfields design and maintenance technology, improved specifications for asphalts and asphalt concrete mixtures, stabilization of roadbed foundations, permafrost, transportation planning, railroads, and pipelines need to be addressed. Solutions to these problems will result in lower maintenance costs, improved site accessibility, better linkage between communities, lower users costs, and a cost-effective means for transport of goods and people. This will definitely provide a cornerstone for the industrial development of the State. In this regard, TRC has established working partnerships with the private sector and the Alaska Department of Transportation and Public Facilities (AKDOT&PF) that would address these problems and provide solutions significant to the economic growth of the State.

Moreover, TRC recognizes the importance of the human resource factor and its contribution to the growth of Alaska. TRC, therefore, provides engineering students the opportunity to specialize in transportation engineering and attain excellent capability to work in the State and provide practical solutions to critical transportation problems. These students will be an invaluable asset to Alaska since they would provide an in-house human resource with technical expertise to build the State and promote its growth. Responding to this need TRC offers courses in pavement and bridge design, maintenance and management, transportation materials, transportation systems simulation, transportation planning, and transportation economics. Currently, TRC, in cooperation with the Institute of Transportation Engineers (Alaska Chapter), is developing a continuing education program in transportation engineering for practicing Alaskan engineers.

TRC is also conducting research in order to provide practical solutions to a number of challenging transportation problems in Alaska. More than twenty research projects are currently being investigated in areas of permafrost stabilization, rubber - asphalt, materials specifications, cold region concreting, utilization of Alaskan coal ash in highway construction, deferred road maintenance criteria, culvert design for safe fish passage, risk of hazardous wastes transportation, bridge decks, and transit and paratransit needs. The general sources for research funding include the Alaska Department of Transportation and Public Facilities, the Alaska Science and Technology Foundation, Federal Transit Authority, Federal Highway Administration, and numerous private corporations. Research results are published in reports and journal articles and are presented at national and international conferences.

In another endeavor, TRC cooperates with AKDOT&PF in directing and managing the Alaska Cooperative Transportation and Public Facilities Research Program (CTPRP). The major objectives of this program are to identify research needs, prioritize objectives, provide research services, and disseminate the results to practicing engineers.

TRC is also a member of the Northwest Universities Transportation Research Consortium (NUTRC) representing the University of Alaska Fairbanks. Together with other leading universities in the northwest such as the University of Washington, Washington State, Portland State, Oregon State, and the University of Idaho, TRC participates in conducting research and developing common educational programs in Transportation Engineering. In addition, TRC sponsors the Alaska Transportation Forum, an annual colloquium for addressing and discussing urgent transportation issues especially germane to our State.

Faculty

TRC faculty fall in two categories:

1. Core Faculty

These faculty will teach, conduct research, and perform other administrative duties at TRC. They provide unique expertise that complements the multidisciplinary nature of transportation engineering. These faculty members include:

Lutfi Raad, Ph.D.(University of California-Berkeley)
Associate Professor of Civil Engineering and TRC Director
Pavements;materials;soils

J. Leroy Hulsey, Ph.D., PE (University of Missouri-Rolla)
Associate Professor of Civil Engineering
Bridges;structures

Tom C. Kinney, Ph.D., PE (University of Illinois, Urbana)
Associate Professor of Civil Engineering
Geosynthetics;permafrost;foundations

Nick Coetzee, Ph.D., PE (University of California-Berkeley)
Adjunct Professor of Civil Engineering
Pavement analysis; pavement management; non-destructive testing

John Lu, Ph.D., PE (University of Texas at Austin)
Research Assistant Professor of Civil Engineering
Traffic analysis; transportation operations

Mohamad Succarieh, Ph.D. (Rensselaer Polytechnic Institute)
Assistant Professor of Civil Engineering
Soil dynamics;earthquake engineering;retrofitting

Diane Bischak, Ph.D. (University of Michigan)
Assistant Professor of Business Administration
Transportation systems; Transportation simulation

Gregg Goering, Ph.D. (Purdue University)
Assistant Professor of Economics
Transportation Economics

Suzan Todd, MA (University of Michigan)
Visiting Assistant Professor of Land Planning
Transportation planning

2. Affiliate Faculty

These faculty contribute to the research effort of TRC and team up with core faculty on research proposals requiring their expertise.

Robert F. Carlson, Ph.D., PE (University of Wisconsin)
Professor of Civil Engineering
Hydraulic structures;Bridge scour

Kevin C. Curtis, Ph.D. (Colorado State University)
Assistant Professor of Civil Engineering
Structures;Timber

Doug Kane, Ph.D., PE (University of Minnesota)
Professor of Civil Engineering
Water resources;Hydrology;Fluid mechanics

Mark A. Tumeo, Ph.D., PE (University of California-Davis)
Associate Professor of Civil/Environmental Engineering
Risk analysis;Hazardous waste transport

Larry Hinzman, Ph.D. (University of Alaska Fairbanks)
Research Assistant Professor in Civil Engineering/Water Resources
Hydrology;Water resources

Doug Goering, Ph.D. (University of California-Berkeley)
Assistant Professor of Mechanical Engineering
Heat transfer; Numerical modeling

John P. Zarling, Ph.D., PE (Michigan Tech. University)
Professor of Mechanical Engineering
Heat transfer; Numerical modeling

Larry Bennett, Ph.D., PE (Cornell University)
Professor of Engineering Science Management
Engineering management;Logistics;Scheduling

Courses

The following is a list of undergraduate and graduate courses that are generally recommended for students majoring in Transportation. A selection of graduate courses could be tailored to suit the student's interests and background. Graduate work generally leads to the following degrees:

a) Master of Science in Transportation Engineering

b) Master in Transportation Planning and Systems Operations

c) Ph.D. in Transportation Engineering (Interdisciplinary Program)

Emphasis in graduate work could be on pavements, highway materials and soils or on transportation planning and systems operations. Major courses cover areas required for completion of the basics whereas as minor courses will complement the student's background and in many cases will be needed to satisfy speciality requirement for the Ph.D. degree.

Undergraduate Courses

CE 326 Introduction to Geotechnical Engineering
CE 334 Properties of Materials
CE 402 Introduction to Transportation Engineering
CE 403 Traffic Engineering
CE 404 Highway Engineering
CE 415 Advanced Surveying
CE 422 Foundation Engineering
CE 494 Introduction to Pavement Engineering
STAT 300 Statistics
STAT 401 Regress/Analy Variance
STAT 461 Applied Multivariate Statistics

Graduate Courses

Major

CE 605 Pavement Design
CE 625 Soil Stabilization
CE 676 Coastal Engineering
CE 681 Frozen Ground Engineering
CE 693/001 Soil Behavior
CE 693/002 Transportation Systems Analysis
CE 693/003 Transportation Economics
CE 693/004 Bridge Design, maintenance, and Rehabilitation
CE 693/005 Advanced Traffic Engineering
CE 693/006 Transportation Planning Theory
CE 693/007 Transportation Planning Practicum
CE 693/008 Airport Planning Engineering
CE 694/001 Prop. of Asphalts and Asphalt Concrete Mixtures

Minor

AIS 605 Management Information Systems
ME 601 Finite Element Analysis
ME 631 Advanced Mechanics of Materials
ME 642 Advanced Heat Transfer
ME 685 Arctic Heat and Mass Transfer
MATH 608 Partial Differential Equations
MATH 615 Applied Numerical Analysis
MATH 622 Advanced Applied Analysis
MATH 660 Advanced Mathematical Modeling
MATH 661 Optimization
NRM 640 Simulation and Modeling in Natural Resources
NRM 641 Natural Resource Applications of Remote Sensing

STAT 602 Experimental Design
STAT 661 Sampling Theory

TRANSPORTATION RESEARCH CENTER FACILITIES

UNIVERSITY OF ALASKA FAIRBANKS
SCHOOL OF ENGINEERING
EQUIPMENT AND FACILITIES

The Transportation Research Center (TRC) at the University of Alaska Fairbanks (UAF) has access to state-of-the-art equipment and facilities at the university for conducting transportation related research for the Alaska Department of Transportation & Public Facilities (AKDOT&PF).

The facilities include laboratory testing equipment for conducting research on soils, materials, pavements, and bridges; a test track for testing roadway pavement, geotextile applications, and bridge decks; and state-of-the-art methods for evaluating the performance of transportation facilities.

The following paragraphs provide a summary of these facilities.

MATERIALS TESTING FACILITIES

The School of Engineering at the University of Alaska Fairbanks has acquired, over the last ten years, state-of-the-art testing facilities to determine the behavior of materials under different loading and temperature conditions.

Soil testing cover the traditional classification tests and identification in addition to sophisticated strength tests, such as the triaxial and consolidation tests. Repeated load triaxial tests to characterize typical bases, subbases, and subgrade soils in pavements can be conducted on cylindrical specimens up to 4 in. diameter by 8 in. height. Both controlled-stress and controlled-strain tests could be performed for specimens in the moist compacted or saturated conditions. Pore water pressure development could be monitored and volume compressibility measurements are possible.

Testing of asphalt and asphalt concrete materials is performed through typical penetration and viscosity tests (including Brookfield viscometer), specific gravity, ductility, R&B softening point, and Marshall stability. Impact, kneading and rolling compactors are available for preparation of mix specimens. High shear mixing equipment has been acquired recently to prepare polymer modified asphalts. Other testing equipment include flexure fatigue and diametral split tension and resilient set up, in addition to a newly acquired (end of Summer 1994) Thermal Stress Restrained Specimen Test (TSRST) system that provides the capability of evaluating thermal cracking resistance of asphalt concrete mixtures. Durability test equipment is also available to evaluate the durability of asphalt concrete mixtures under freeze-thaw cycling between 4.4°C and -17.8°C. Cycle duration can vary between 3 hours and 5 hours, and a total of 300 cycles could be applied.

Other testing facilities are available for concrete and timber testing. Most of standard ASTM tests on strength and durability of concrete, Portland cement, and timber can be performed.

In addition to the above, the School of Engineering realized the importance and significant role of the University in establishing a center of excellence in Cold Regions Engineering. To this effect, the School of Engineering maintains an excellent set of equipment and facilities. These include: Universal Frost Heave equipment that allows measurement of heave in soils under different temperature, moisture, and pressure boundary conditions; two large cold rooms (16 ft by 14 ft by 14 ft) with temperature control from -40°C to +40°C; thermal units with temperature with programmable temperature control capabilities between -100°C and +100°C.

MATERIALS & STRUCTURAL LOAD TESTING MACHINES

The School of Engineering at the University of Alaska Fairbanks has two state-of-the-art testing machines for performing fatigue, dynamic, and static tests on materials for pavements and bridges, etc. The facilities at UAF are unique because they provide the capability to evaluate the performance of materials under extreme temperature conditions; these capabilities have been prepared especially to meet the Alaskan environmental conditions. These facilities are typically not found at other universities. The details of the machine capabilities are presented below.

Laboratory (MTS) Load Test Machines

There are two MTS material test systems available. The first system has the following subsystem:

(1) Model 311.31 Load frame with hydraulic head lifts and locks. It is a 4-column design and has up to 220,000 pound capacity. The maximum distance from the load cell to the actuator is 40 inches. The load frame stiffness is 12×10^6 pounds per inch.

(2) Model 204.91C-05 Hydraulic actuator. This actuator was designed for a 220,000 lb load frame and provides up to 6 inches of stroke.

(3) Electronic control system. The subsystem mainly consists of a Model 442.11 controller, Model 440.13 Servo-valve controller, signal conditioners for both LVDT and strain gage type transducers, Model 410.31 function generator, Model 417.01 Load pulse counter and control unit, and many other modules for monitoring, recording and safety purposes.

The Model 442.11 controller can be set to either load, stroke or strain control mode and each mode has 4 ranges, 100%, 50%, 20% and 10% of full capacity, which depends on the selected transducers, such as LVDTs, load cells or strain gauges.

The Model 410.31 function generator is capable of applying both sinusoid and stepped-ramp type deflection, load or strain. The breakpoint during stepped-ramp type loads can be either automatic or manual operation. The loading frequencies for both the waveforms can be from 0.1×10^{-5} to 900 HZ. A Model 417.10 load pulse counter and control unit may be used to count the load cycles or to shutdown the system at a preset number. It can also be used to display preset load cycles.

In the current setup, this system is connected with a HP3497 Data Acquisition system. For the fast data collection, a HP7090A measurement plotting system is utilized. It can provide a sampling rate up to 33.3k samples per second with 1000 sampling points for each of three channels. However, the continuous data collection with the HP7090A is limited by its storage memory.

The hardware connections between the MTS electronic control system, the HP3497 data acquisition system and the HP7090A measurement plotting system are determined by the configurations of a relay multiplexer assembly on the HP3497.

The whole system is controlled by a PC computer through a HP instrument interface board.

<u>The second system is an MTS 810 system.</u>

It consists of a Model 318.25 Load unit, Model 458.20 MicroConsole with Model 459.16 TestLink connector interface and a PC computer equipped with a DT2809 analog and digital I/O board.

The Model 318.25 load unit is a 2-column design and has up to 55 KIP capacity. The clearance between the columns is 25 inches and the maximum distance from load cell to actuator is 65 inches.

A special feature of the Model 458.20 MicroConsole is that it can either use its internal function generator or an external function generator as its exciting signal source, which gives users the possibility to load with any waveform. In the internal mode, the Model 458.91 MicroProfiler, the function generation modules of the MicroConsole can be directly controlled by a computer through its RS-232 interface port.

The system sampling rate is mainly dependent on the DT2809 I/O board, which has up to 16 KHZ capacity for each channel.

ACCELERATED PAVEMENT TESTING FACILITIES

Transportation Research Center Pavement Test Facility

The Transportation Research Center at the University of Alaska Fairbanks has a Pavement Test Facility located approximately 8 miles from the Civil Engineering Department. The facility was constructed by the Civil Engineering Department in CRREL Building #16 at the CRREL field research test site. Funding was provided by the private sector from Tensar Earth Technologies and Shannon and Wilson, Inc.

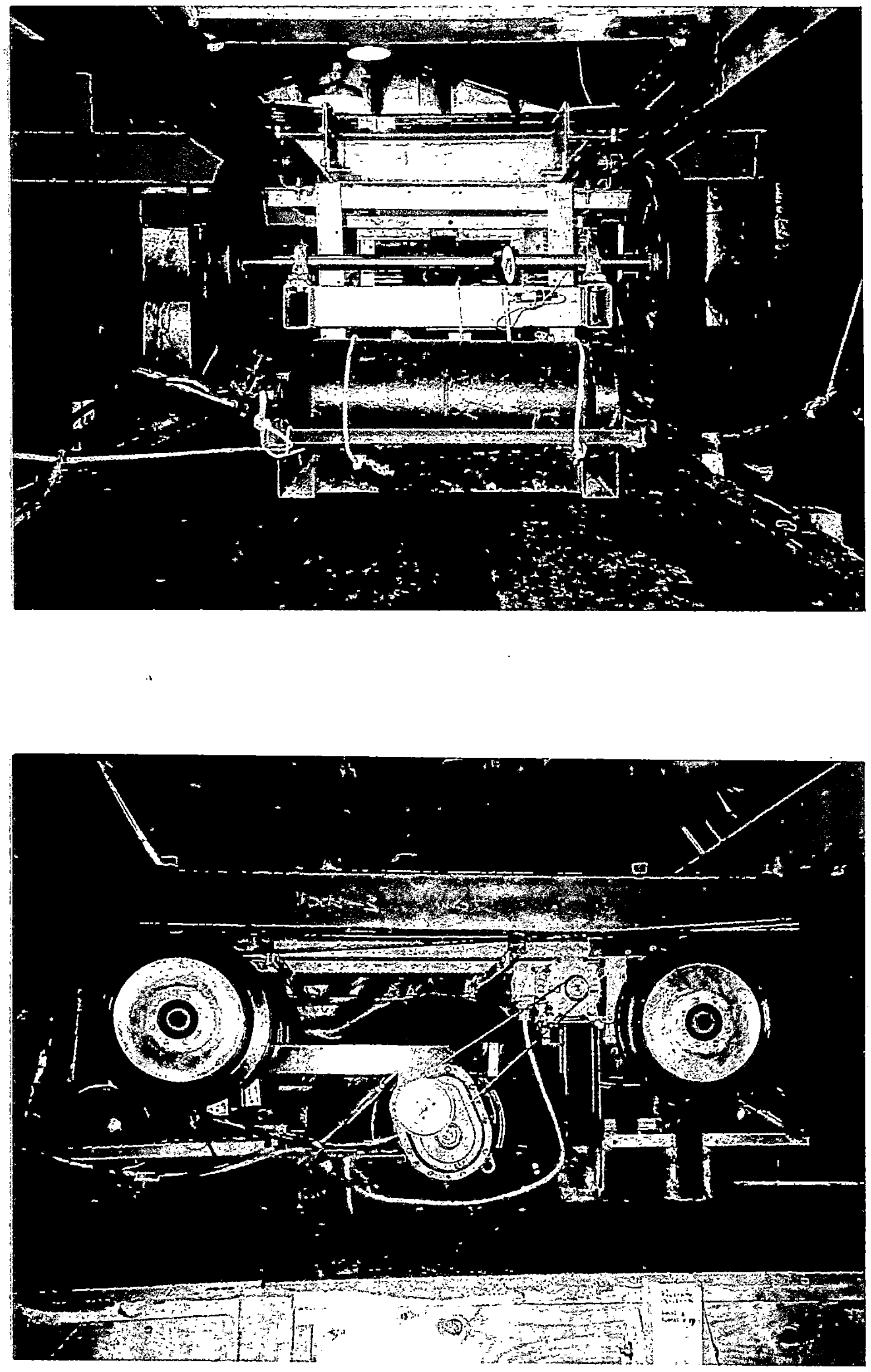

Figure 1. Transportation Research Center Pavement Test Track Facility - Wheel Loading Assembly