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# ADVANCED CONSTRUCTION TECHNOLOGY RESEARCH EQUIPMENT

FINAL REPORT

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Final Report to the  
U.S. Army Research Office  
on  
Grant No. DAAL03-86-G-0186

ADVANCED CONSTRUCTION TECHNOLOGY CENTER  
UNIVERSITY of ILLINOIS at URBANA-CHAMPAIGN  
URBANA, ILLINOIS

22 SEPTEMBER 1992

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**FINAL REPORT**

**SEPTEMBER 22, 1992**

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FOR  
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**ADVANCED CONSTRUCTION TECHNOLOGY CENTER  
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN  
URBANA, ILLINOIS**

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13. ABSTRACT (Maximum 200 words)  
  
This report describes the research equipment purchased under the terms of a grant from the U.S. Army Research Office. The grant was part of the Department of Defence - University Research Initiative Program.

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## ADVANCED CONSTRUCTION TECHNOLOGY RESEARCH EQUIPMENT

This report describes the equipment purchased by the University of Illinois Advanced Construction Technology Center with funds provided by the U. S. Army Research Office under Grant No. DAAL03-86-G-0186. In September, 1986, the U. S. Army Research Office selected the University of Illinois at Urbana-Champaign to develop a center of excellence in Advanced Construction Technology. The Center's research goal is to advance the scientific technologic base necessary to support a major infusion of advanced technology into aspects of construction engineering to reduce significantly the life cycle costs of Army base support facilities. The rationale for this goal is a large number of Army facilities nearing the end of their useful life and lack of adequate funds to replace these facilities at contemporary construction prices.

The Center's research program is organized into the following five thrust areas:

- 1) Nondestructive Evaluation Technologies for Constructed Works
- 2) Construction Site Metrology
- 3) Computer Aided Construction
- 4) New Technologies and Materials for Building Construction
- 5) Special Technologies

The research equipment described in this report was essential for developing research projects in the thrust areas listed above. Since the research program of the Center is interdisciplinary involving faculty and students in the department of Civil Engineering, Mechanical and Industrial Engineering, Electrical and Computer Engineering, Computer Science, Material Sciences, and the School of Architecture, the equipment provided makes a substantial contribution to the general research program of the University as well as specific activities of the Advanced Construction Technology Center.

The original equipment grant from ARO, DAAL03-86-G-0186, was for the amount \$999,764.00 with the effective date of October 1, 1986. The list of equipment purchased along with other data required was submitted to ARO on January 30, 1988 and acknowledged by ARO letter SLCRO-IP-IP-L-24606.1-EG-UIE dated March 8, 1988. Subsequently, the grant was modified as follows:

<u>Modification No.</u>	<u>Effective Date</u>	<u>Amount</u>
P00005	April 1, 1988	\$ 206,765.00
P00007	April 1, 1989	\$ 158,445.00
P00011	April 1, 1990	\$ <u>165,013.00</u>
TOTAL		\$ 530,223.00

This report provides data regarding the equipment purchased with the three modifications noted above for the amount of \$530,223.00.

A list of the research projects in the Center is given in Table II.

The assistance given by the Army Research Office to the University of Illinois to acquire the equipment described herein and to develop the center of excellence in Advanced Construction Technology is greatly appreciated.

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TABLE I

LIST OF EQUIPMENT PURCHASED

Note: Many equipment items were used for several projects. In this table, they are listed in one primary project.

PROJECT NUMBER	PROJECT TITLE/ /ITEM DESCRIPTION	MANUFACTURER	PURCHASE PRICE
19	USE OF COMPUTER VISION TECHNIQUES IN NDE OF STRUCTURAL DAMAGE		
	N. Amer Country Kit	Sun Microsystems	<u>8,998.00</u>
		Subtotal	8,998.00
20	SMART STRUCTURES USING EMBEDDED OPTICAL FIBER STRAIN SENSORS		
	Apple keyboard local talk	Apple	2,102.00
	Memory, apple system	Apple	445.00
	Exit slip grooved rule grating dual grating turret	Spex Industries	27,725.00
	Lockin amp. Chopper	Stanfor Res. Systems	5,001.30
	Optical table fiber coupler	Newport Corp.	976.34
	Fiber positioner fiber chuck riser block	Newport Corp.	1,354.18
	Temperature controller silicon	Scientific Instr. Inc.	2,987.36
	Grip interface for PC/AT	Capital Equipment Corp.	401.65
	Vertical laser mount singlemode polarized lazer	Control Optics	824.00
	Mini rotor mica retardation	Oriel Corp.	266.85
	Interface module oscilloscope	Hewlett Packard	2,736.50
	Preamplifier, lock in amplifier	Stanford Research Systems	4,014.20
	Fiber optic positioner base plate, riserblock	Newport Corp.	312.20
	Labview software card for Mac II; I/O card; I/O connector block	National Instruments	\$ 3,781.50
	MacIntosh II w/ 16" color monitor; ext. keyboard; Powerbook 170 w/FAX modem; Powerbook rechargeable battery; Local Talk conn. kit	Apple	8,910.00
	HP Paintjet XL 300 color printer	Hewlett Packard	2,621.25
	Portable enclosure signal cond. amp.	Measurement Group Inc.	2,250.00
	Tube heater splice protection sleeves	Alcoa-Fujikura	822.00
	Fusion splicer	Aurora Instruments	999.28
	Optical power meter detector head Eprom card	Newport	2,924.00
	Optical table 900x1800 mm	Newport	4,973.25
	Signal cond. ampl.	Measurements Group Inc.	3,825.00
	900x1500 mm optical table supporting legs	Newport	2,568.00
	Group A SI temperature sensors	Adv. Res. Systems	195.00
	Germanium photodetector detector power supply	N.Coast Optical Sys & Sen.	<u>7,170.00</u>
		Subtotal	\$ 90,185.86

22 NDE OF DAMAGE IN STRUCTURES USING  
FORCED DYNAMIC RESPONSE MONITORING

Control kit for NDE	MTS Systems	<u>7,205.00</u>
	<b>Subtotal</b>	<b>\$ 7,205.00</b>

23 ELECTROMAGNETIC SENSING OF CONCRETE

Air lines and cables	Hewlett Packard	2,044.00
Math co-processor	Microway	993.00
Z-386 computer	Zenith	4,268.00
Math co-processor	AT & T	1,054.68
Ethernet controller	Atek	516.72
Laser printer	Hewlett Packard	774.50
Steel plate	UI Elec. & Comp. Eng. Shop	57.85
Angle iron	UI Elec. & Comp. Eng. Shop	17.14
SPARC station	Sun Microsystems	9,209.50
Laserjet printer & parallel	Hewlett Packard	1,743.00
Information service	Atek	255.00
Sigma Shubox enclosure	Fujitsu	2,197.50
Central Stores		<u>843.00</u>
	<b>Subtotal</b>	<b>\$ 23,973.89</b>

24 ACCELERATED TESTS FOR SOIL PROPERTIES

H-10 vane borer	Geonor	10,585.16
Volume change unit	Wykeham Farrance	879.70
Volume change unit	Wykeham Farrance	909.70
Temperature controller	Baxter Scientific	1,261.16
Dial gauge	Wykeham Farrance	1,071.30
Digital strain indicator	Precision Measurements	2,069.53
Compression machine	Wykeham Farrance	13,565.00
Transducer	Dynisco	531.83
Hydraulic work positioner for transducer	Common Equipment	990.62
Load cell and compression proving ring	Wykeham Farrance	4,183.52
Digital strain indicator, switch, balance	Measurement Group	4,137.33
Temperature controller & stirrer	Baxter Scientific	862.92
Gateway 486/33 cache computer system	Gateway 2000	<u>1,856.65</u>
	<b>Subtotal</b>	<b>\$ 42,904.42</b>

26 NDE OF MASONRY BUILDINGS

Impulse force hammer	Kistler Instruments	945.50
Electrical connector	Imo Delaval	306.83
Hydraulic power pack	S & K Air Power	226.80
Hydraulic power pack	S & K Air Power	1,359.06
Displacement transducers	Trans-Tek	4,644.50
Shop Supplies	UI CE Shop	253.32
Concrete saw & blades	Midwest Tool	4,285.00

Hydraulic power pack	Hewlett-Packard	3,995.00
Compression load cell	Sensotec	551.72
Displacement transducers	Trans-Tek	3,863.26
25mm lens for AID-500	Applied Intelligent System	409.47
Data acquisition software	Metrabyte Corporation	1,003.95
Disk drive, 200mb scsi	Hewlett-Packard	1,257.60
Comp I	Hewlett-Packard	<u>3,406.90</u>
	<b>Subtotal</b>	<b>\$ 26,508.91</b>

27                    **AN ENGINEERING APPROACH TO NDE OF MATERIAL PROPERTIES**

Waveform and spectrum	LeCroy	5,245.50
Ultrasonic pre-amplifier	Panametrics	575.00
Ultrasonic transducers	Panametrics	<u>1,950.22</u>
	<b>Subtotal</b>	<b>\$ 7,770.72</b>

28                    **REAL-TIME NDE FOR HARDENING CONCRETE**

Driver board	Metrabyte Corporation	<u>1,408.03</u>
	<b>Subtotal</b>	<b>\$ 1,408.03</b>

30                    **NDE SYSTEM**

Z386 computer	Zenith	4,268.00
Laser printer	Hewlett Packard	774.50
Workstation	Sun Microsystems	4,604.75
370CH 900 model mainframe & software	Hewlett Packard	20,000.00
Parallel digital I/O interface	IBM	130.56
Shop Supplies	UI CE Shop	173.55
Spectrum/network analyzer & modules	Hewlett-Packard	21,726.90
Gateway 386SX for use with above analyzer	Gateway 2000	2,195.00
Apollo computer system	Hewlett-Packard	22,206.80
Colorsript 100 Model 10 printer	QMS	3,116.77
Colorsript 100 Model 10 printer	QMS	500.00
DR-9400/8MB (4MBx2) for HP 9000/380 work stations	Dataram Corp.	1,031.00
1.2 GB disk drive	DataLink	85.25
1.3 GB 4MM 5.25" DDS tape; Sigma internal chassis for HP/in-ext cables; 6 ft. SCSI shielded	DataLink	4,359.75
HP9000 series 300 upgrade for model 350 to 6804D	Hewlett Packard	4,000.00
400T to 425T upgrade	Hewlett Packard	<u>1,240.00</u>
	<b>Subtotal</b>	<b>\$ 90,412.83</b>

31                    **ION-PLATED COATINGS FOR EMI/EMP AND CORROSION APPLICATIONS**

Turbo pump package	Balzars	13,600.00
Apple keyboard; Apple system	Apple	<u>2,575.00</u>
	<b>Subtotal</b>	<b>\$ 16,175.00</b>



33 HIGH PERFORMANCE CEMENTIOUS MATERIALS

Ultrastyrigel column	Waters Chromatography	732.11
Ultrastyrigel columns	Waters Chromatography	1,462.63
Shop Supplies	UI CE Shop	21.92
Liquid chromatography equipment	Waters Chromatography	<u>14,629.50</u>
	<b>Subtotal</b>	<b>\$ 16,846.16</b>

34 ON-LINE MEASUREMENT OF DISPLACEMENT DURING WELDING USING LASER INTERFEROMETRY

CDD camera	Chori America	1,136.75
Peripheral image processing system	Vicom Systems	42,975.04
HeNe laser	Newport Corporation	1,305.70
Used press camera	Polaroid	399.00
CR T/yoke and assembly	Hewlett Packard	<u>150.00</u>
	<b>Subtotal</b>	<b>\$ 45,966.49</b>

35 ADVANCED CERAMICS FOR BUILDING CONSTRUCTION

Rebuilt DTA	Innovative Thermal System	7,100.00
Lab blender	Patterson-Kelley	3,290.00
Isomet low speed saw	Buehler, Ltd.	1,994.14
Materials microscope	Nikon	1,202.00
Gravity convection oven	Fisher Scientific	736.50
Digital display viscometer	Brookfield Engineering	1,952.29
Digital viscometer	Brookfield Engineering	1,942.19
Volume change indicator	Humboldt	607.14
Compression testing machine	Forney	8,830.30
Fume hood	Fisher Scientific	2,409.56
Basic balance	Mettler	1,073.00
5-quart mixer	Hobart	1,200.00
Vertical cylinder capping set	Humboldt Manufacturing	855.00
Muffle furnace	Thermolyne	911.00
Temperature controller	Thermolyne	1,790.00
Furnace, type 30400	Thermolyne	5,212.58
Double wall drying oven	Fisher Scientific	920.00
Mold	Swanson Machine Company	657.07
Charges for parts & labor for design and construction of F-meter	School of Chemical Sciences	659.79
Modify mold 1½x1¼ X-095 sq. tube	Swanson Mach. Co.	622.36
Electronic platform scale 150 lb cap. w/ indicator	Soiltest Inc.	1,402.70
Model CS-266B shear compression machine	CSI	1,683.00
Trinocular head adapter-camera mount lens (proj)	Frank E. Fryer	<u>824.04</u>
	<b>Subtotal</b>	<b>\$ 47,874.66</b>

40                    **ACTIVE VISUAL ACQUISITION OF 3-D STRUCTURAL  
DATA FOR CONSTRUCTION**

Hewlett optical disk subsystem for sun sparc. rewritable M/O media 650 MB, datacard 24 hr. service (replacement)	DataLink	4,860.65
Cohu 1/2" format RGB color CCD camera with 115 VAC transformer and sync, remote and RGB connectors; RGS cable assembly	Nuclear Sec. Serv. Corp.	3,551.97
1.4 GB disk drive, power supply, cables, chassis	North Central Peripherals	<u>2,660.25</u>
	<b>Subtotal</b>	<b>\$ 11,072.87</b>

45                    **3-D METRIC VISION FOR ENGINEERING CONSTRUCTION**

Video data monitor	Panasonic	706.00
Digitizer	Geographics	3,960.00
Lenses	Lukas Microscope	553.53
Standard X-Y stage	Ealing Electro-Optics	2,779.53
Silicon video MUX & accessories	Pulnix	6,026.00
Printer & cable	CS Computer Sales	15.00
Plotter, 6-pen	Hewlett-Packard	1,142.00
Camcorder CCD	Sony	988.89
Hardcard for IBM PC/AT	IBM	627.00
Computer Z-386, monitor, and math co-processor	Zenith	4,757.00
Computer package	Xeos International Ltd.	<u>3,372.00</u>
	<b>Subtotal</b>	<b>\$ 24,926.95</b>

52                    **NEW TECHNOLOGIES IN GEOTECHNICAL ENGINEERING:  
IN-SITU SOIL REINFORCEMENT**

Vertical lift bucket	Thomas Conveyor	4,990.00
Styrofoam dervitz	Harlan E. Moore	381.00
Steel rebars	Central Steel & Wire	2,955.00
PVC coupler	Field & Shorb	1,091.24
Super concrete	Central Material Company	560.00
PVC schedule pipe	Field & Shorb	462.32
Bolts, nuts, washers	Fastenal	40.88
Sand, washed and dried	Cornick Concrete Products	2,260.00
Coil belts	Dayton	2,228.97
Chain	S & K Air Power	2,760.30
Miscellaneous threadbars	Dywidag Systems	3,375.23
Belt conveyor	Thomas Conveyor	4,990.00
Subtraction cone penetrometer	Hogentogler & Company	11,955.00
Signal logging system	Hewlett Packard	16,168.50
DVM and current source	Hewlett Packard	1,620.00
Aircraft tubing, stainless steel	Tube Sales	1,545.00
Aircraft tubing, stainless steel	Tube Sales	286.65
Double proving ring	Soiltest, Inc.	527.99
Extensometer dial gages	Peacock	414.45
Gum tubing	Greene Rubber Company	180.15

Film & Batteries	UI CE Shop	363.52
Gages	Measurements Group, Inc.	272.00
Materials	UI Materials Research Lab	325.19
Transfer tubes, hollow rod	UI Materials Research lab	428.68
Termcard	Hewlett Packard	570.00
Shop Supplies		1,118.20
(shed; 274.00, May True Value Hardware)		
(Sin Flex Duct & Strap; 49.21, Capitol Group)		
(nuts, bolts, & couplers; 460.62, Potter Form & Tie Co.)		
(blower; 282.92, McMaster-Carr)		
(clamps; 51.45, Furrows)		
Volume blower	McMaster-Carr	790.86
Steel	Kurland Steel Co.	345.00
PVC pipe	Field & Shorb	124.24
9 gage chain link fence	Bob Shaver Inc.	317.50
Shop Supplies	UI CE Shop	85.54
(hand wench; 52.13)		
(tubing; 33.42)		
Shop Supplies	UI CE Shop	2,673.78
(Belden computer cable; 1,155.00)		
(Belden computer cable & terminals; 1330.60)		
(rods, ferrule, & alum. plate; 185.34)		
Materials charges	UI CE Shop	979.72
(misc. nuts & bolts; 6.18)		
(tubing; 561.06)		
(rubber tubing; 182.75)		
(valves & connectors; 229.73)		
Gages	Measurements Group, Inc.	785.40
Shop Supplies	UI CE Shop	<u>20.90</u>
	<b>Subtotal</b>	<b>\$ 67,993.21</b>
	<b>GRAND TOTAL</b>	<b>\$ 530,223.00</b>

## TABLE II

### **Thrust Area: Nondestructive Evaluation (NDE) Technologies for Constructed Works**

"Reduced Structural Dynamics Calculations"  
Project No. 21 - A.R. Robinson

"NDE of Damage in Structures Using Forced Dynamic Response Monitoring"  
Project No. 22 - K.D. Hjelmstad and S.L. Wood

"Electromagnetic Sensing of Concrete"  
Project No. 23 - W.C. Chew

"Accelerated Tests for Soil Properties"  
Project No. 24 - R. Mesri and W. Tang

"NDE of Masonry Buildings"  
Project No. 26 - D.P. Abrams

"An Engineering Approach to NDE of Material Properties"  
Project No. 27 - D.L. Marriott and R.L. Weaver

"NDE System"  
Project No. 30 - W.C. Chew and H. Lee

"On-Line Displacement Monitor to Measure Residual Stress"  
Project No. 34 - D. Socie and J. Mazumder

"Real-time NDE for Hardening Concrete"  
Project No. 33 - J.F. Young and R.L. Berger

### **Thrust Area: Construction Site Metrology**

"Visual Acquisition of Three-Dimensional Structural Data for Construction"  
Project No. 40 - N. Ahuja

"3-D Vision for Engineering Construction"  
Project No. 45 - K.W. Wong

"Imaging and Vision Systems for Automated Construction"  
Project No. 43 - H. Lee

### **Thrust Area: New Materials and Technologies for Building Construction**

"Corrosion Resistant Oxide Coatings from Metalloorganic Precursors"  
(Thesis scale) R.C. Buchanan

"High Performance Cements"  
Project No. 33 - J.F. Young and R.L. Berger

"Advanced Ceramics for Building Construction"  
Project No. 35 - G.P. Wirtz, R.C. Buchanan, and C. Dry

"A Flexible Manufacturing Systems Approach for Automation  
of Building Construction"  
Project No. 36 - S.G. Kapoor and U.S. Palekar

"Lightweight, Energy-Efficient Building Material Concepts"  
Project No. 32 - T.A. Newell

"A Unified Knowledge-based Model for Building Design and Construction"  
Project No. 37 - L. Lopez and J. Garrett

**Thrust Area: Computer-Aided Construction**

"Design for Automated Construction"  
Project No. 42 - L.T. Boyer

"Handling Constraints in an Object-Oriented Database"  
Project No. 41 - G.G. Belford

"Sensor-based Intelligent Manipulators for Automated Construction"  
Project No. 44 - S.C.-Y. Lu

"Object-Oriented Building Model for Integrating Design"  
Project No. 48 - J.W. Melin

"An Integrated Arc-Spray Depositing System"  
Project No. 47 - G.G. Belford, L. Boyer, H. Lee, J.W.-S. Liu, S. Lu and K. Wong

**Thrust Area: Special Technologies**

"Advanced Thin Film Materials for Construction Applications"  
Project No. 31 - J.M. Rigsbee

"In Situ Soil Reinforcement-Soil Nailing"  
Project No. . 2 - J.H. Long and E.J. Cording

"EMP/EMI Testing and Assessment"  
Project No. 51 - J.T. Verdeyen

"Horizontal Construction - Improved Facility Design, Construction, and  
Rehabilitation"  
Project No. 51 - E.J. Barenberg and M.R. Thompson