

**PART THREE APPENDICES**

TABLE A-1

FEDERAL SPENDING FOR INFRASTRUCTURE-MATERIALS R&D:

DEPARTMENT OF TRANSPORTATION, FEDERAL \* HIGHWAY ADMINISTRATION

Program	FY 85	FY86	FY87
<u>Highway Operation</u>			
Highway Maintenance - materials for	00,000	149,174	0
Calcium Magnesium Acetate De-icer	248,240	10,257	0
Subtotal	348,240	159,431	0
<u>Pavement Design, Construction &amp; Management</u>			
Rigid Pavement Design/rehabilitation (Concrete)	744,340	758,031	225,673
Flexible Pavement Design/Rehabilitation (asphalt)	211,307	551,659	450,000
Improved Flexible Binders (asphalt & synthetics)	227,052	0	15,000
Construction Control & Management (Test methods-quality)	36,558	0	250,000
Vehicle Surface Interactions (Pavement behavior data)	368,593	273,659	0
Subtotal	1,587,850	1,583,349	940,673
<u>Structural Design and Hydraulics</u>			
Bridge Rehabilitation Technology (NDE,assessment,guidelines)	384,685	337,165	623,535
Bridge Maintenance & Corrosion Protection	437,383	436,950	249,015
Subtotal	822,068	774,115	872,550
Total FHWA Research Spending Materials Related	2,758,158	5,689,549	1,813,223
Direct materials work	2, 6,562	1,767, 54	939,688

ABL 5 A-2

ARMY CORPS OF ENGINEERS INFRASTRUCTURE MATERIALS R&D

CONSTRUCTION ENGINEERING RESEARCH LABORATORY

Selected Projects	Prior Years	FY '86	FY '87	FY '88	FY '89
Nondestructive Evaluation of Deteriorated Metal Structures	\$200,000	\$30,000	\$0	\$0	\$0
Structure Damage Index to Determine the Remaining Life & Reliability of Metal Structures	\$50,000	\$100,000	\$50,000	\$0	\$0
Corrosion Assessment of Reinforcing Wires & Tendons	\$40,000	(\$80,000)*	(\$80,000)*	(\$50,000)*	(\$50,000)*
Corrosion-Resistant Materials for Civil Works Structures	\$100,000	\$100,000	\$50,000	\$0	\$0
Civil Works Corrosion Mitigation and Management System	\$0	\$100,000	\$150,000	\$100,000	\$50,000
Painting of Submerged Surfaces	\$0	\$100,000	\$50,000	\$0	\$0
Development of High-Solid Coatings	\$0	\$0	\$100,000	\$50,000	\$40,000

\* To be funded from savings and savings within the REMR Program.

TABLE A-2, CONTINUED

ARMY CORPS OF ENGINEERS, WATERWAYS EXPERIMENT STATION  
 REPAIR, EVALUATION, MAINTENANCE AND  
 REHABILITATION RESEARCH PROGRAM (REMR)

Selected Projects	Pr or Years	FY '86	FY '87	FY '88	FY '89
Evaluation of Existing Maintenance Materials & Methods	\$280,000	\$175,000	\$150,000	\$150,000	\$150,000
Surface Treatments to Minimize Concrete Deterioration	\$175,000	\$175,000	\$150,000	\$100,000	\$50,000
Techniques for Underwater Concrete Repairs	\$250,000	\$200,000	\$100,000	\$100,000	\$80,000
Techniques for Joint Repair & Rehabilitation	\$145,000	\$175,000	\$200,000	\$150,000	\$120,000
In-Situ Repair of Deteriorated Concrete	\$120,000	\$150,000	\$125,000	\$125,000	\$100,000
Grouting Practices for Repair & Rehabilitation of Rock Foundations	\$375,000	\$275,000	\$150,000	\$50,000	\$75,000
Assessment of Long-Term Performance Characteristics of Resin Grout Rock Bolts	N.A.	N.A.	\$150,000	\$150,000	\$150,000
Field Exposure Durability Studies	N.A.	N.A.	\$45,000	\$50,000	\$55,000
Use of Cementitious Materials Other Than Portland Cement	N.A.	N.A.	\$60,000	\$0	\$0
Unsolved Problems Related to Alkali-Silica Reaction (ASR) in Concrete	N.A.	N.A.	\$60,000	\$60,000	\$55,000
Curing Compound for Concrete	N.A.	N.A.	\$10,000	\$0	\$0
Winter Concreting	N.A.	N.A.	\$0	\$0	\$50,000
Effect of Fly Ash & Other Pozzolans on Concrete Durability	N.A.	N.A.	\$0	\$55,000	\$70,000
Optimizing Pozzolan/Portland Cement Quantities in Concrete	N.A.	N.A.	\$0	\$50,000	\$50,000
Improved Nondestructive Techniques for Concrete Structures	\$50,000	\$150,000	\$150,000	\$150,000	\$100,000
Techniques for Removal of Deteriorated Concrete	\$0	\$0	\$50,000	\$100,000	\$200,000
Methods for Assessing the Condition of Deteriorated Structures	\$0	\$0	\$100,000	\$100,000	\$100,000

TABLE A-3

NATIONAL BUREAU OF STANDARDS INFRASTRUCTURE MATERIALS R&D

	FY '85	FY '86	FY '87
Center for Building Technology			
Polymer Concrete Set Time		\$ 50,000	\$ 70,000
Preliminary Minimum Strength Levels for the Bond of Repair Materials to Existing Concrete Pavements		\$ 55,000	\$ 55,000
Expert System for Durable Concrete	\$45,000	\$81,000	\$40,000
AASHTO Materials Reference Laboratory Cement & Concrete Reference Laboratory Performance Requirement Tests & Criteria for Materials Used to Repair Portland Cement Concrete	\$170,000	\$160,000	\$140,000
Ultra-High Strength Concrete	\$163,000	\$160,000	\$128,000
Quantitative X-Ray Diffraction Analysis of Portland Cement Concrete	\$50,000	\$30,000	\$ 70,000
Influence of Pore Solution Chemistry on Alkali-Silica Reaction		\$ 20,000	
The Influence of Interfacial Microstructure on Bonding in Concrete		\$96,000	
Representation of Concrete Microstructure	\$65,000	\$54,000	\$60,000
Nondestructive Test Methods for Concrete Cement Hydration	\$175,000	\$116,000	\$153,000
Quantitative Characterization of the Surface Properties of Building Materials	\$336,000	\$327,000	\$327,000
Via Computer Image Processing		\$96,000	\$ 00,000
Improved Characterization of Coating System Performance	\$80,000	\$50,000	
Organic Coatings	\$90,000	\$110,000	\$110,000
Degradation of Organic Protective Coatings		\$96,000	\$115,000
Development of Performance Tests & Criteria for Coatings		\$200,000	\$15,000
Volatile Organic Content Compliant Coatings		\$208,000	\$50,000
Cyclic Loading of Masonry Building Components		\$20,000	\$210,000
Technical & Scientific Support	\$22,000		\$25,000
TOTAL	\$1,196,000	\$2,214,000	\$1,820,000

TABLE A-4

## NATIONAL SCIENCE FOUNDATION INFRASTRUCTURE MATERIALS R&amp;D\*

	FY85	FY86	(To date) FY87
Materials-related only Systems Engineering for Large Structures & Division of Critical Engineering Systems			
Dams:			
Dam Failure Workshop	45,500		
Subtotal	45,500		
Water Supply Systems:			
Assessment of aging water supply systems	174,321	54,953	174,971
Engineering methods to assess system upgrades - model			
Decision methods based on assessment of line pipe failure modes	174,321	54,953	174,971
Subtotal			
Sewers - Wastewater Treatment Systems:			
Workshop - research needs on buried line pipe	0	51,685	0
Subtotal			
Highways/Roadways:			
Microadditives for Asphalt Mixtures	110,000		
Reinforced Concrete Degradation	390,110		
Variability of asphalt cements	37,500	35,000	
Electrohydraulic Paving Materials Investigation	55,220		
MDE of Building Materials Contamination	140,970		
Model of Layered Aggregate Pavements	59,993		
Cathodic Protection - Alkali-aggregate reaction deterioration	67,186	114,670	
Subsurface materials to prevent frostheaves		42,000	
Porous Materials durability - equipment		142,593	
Fracture healing in asphalt concrete		169,948	
Fly ash cement for recycling seal coat pavement material			120,179
Plastic Fiber Reinforced Concrete for Large Structures			206,690
Fiber reinforced cementitious composites			49,723
Steel fiber reinforced roller compacted concrete pavement			30,000
Methods/materials for pavement ice control			406,592
Subtotal	860,979	504,071	
Bridges:			
Prestressed Concrete Steel Girders	145,688		
Epoxy Mortar - Highway Bridges	121,343		
Prestressed Concrete Steel Box Girders - seismic eval	161,049		
Deteriorated Steel deck - remaining life	90,000		
Alloy Steel Microcracks - equipment	34,145		
Polymer Construction Materials - equipment	67,000		
Epoxy bonded concrete overlays for seismic reinforcement	141,877		
Shock treatment for weld metal joints to enhance ductility	186,903		
Robotic manufacture of steel deck replacement panels	30,000		
Fatigue life of prestressed composite steel concrete girders	107,725		
Workshop - US-Europe bridge evaluation, repair & rehab	36,194		
Performance evaluation joints in precast concrete segment bridges			94,531
Bond of epoxy-coated reinforcing steel to concrete			223,444
Workshop - US-Japan - Strengthening of Bridges			32,900
Subtotal	761,102	360,822	350,875
OAI - Materials	1,841,902	971,531	932,438

\*Many of these are 2- or 3-year projects.

TABLE A 5

BUREAU OF RECLAMATION FUND FOR INFRASTRUCTURE MATERIALS R&D CENTER

ENGINEERING & MATERIALS DIVISION OF RESEARCH & LABORATORY SERVICES	FY '85 & PRIOR YEARS	FY '86	FY '87
Concrete & Structural			
Concrete Materials Systems Research	\$1,134,000	\$70,000	\$100,000
Superplasticizers & Flowable Concrete	\$71,000	\$30,000	
Verification of Deleterious Levels of Calcium Sulfate Concentration	\$87,000	\$1,000	\$10,000
Repair of Concrete Affected by Alkali-Aggregate Reaction	\$81,000	\$30,000	\$35,000
Fly-Ash Cements	\$60,000	\$20,000	\$30,000
Development of Bond Strength Between Lifts of Roller-Compacted Concrete, Concrete & Structural	\$84,000	\$50,000	\$20,000
Concrete and Structural Total	\$1,517,000	\$215,000	\$195,000
Hydraulics			
Prevention of Cavitation to Flow Surfaces (materials performance)	\$496,000	\$100,000	\$80,000
Drain Envelopes	\$284,000	\$25,000	
Gravel Packs & Well Screens	\$560,000	\$80,000	\$0,000
Hydraulics Total	\$1,340,000	\$205,000	\$80,000
Technical			
Cement Research	\$96,000	\$40,000	\$45,000

TABLE A.5. CONTINUED

	FY '85	FY '86	FY '87
Other Materials & Instrumentation			
Mechanical Properties of Well Screens and Casings (Use of New Materials, i.e., Plastics)	\$43,000	\$20,000	\$10,000
Open & Closed Conduit Systems (Includes materials R&D)	\$1,834	\$120,000	\$110,000
Coating Research & Technology	\$214,000	10,000	\$10,000
Plastic Pipe & Tubing Research	\$220,000	10,000	\$22,000
Seepage & Erosion Control Materials	\$316,000	20,000	\$25,000
Corrosion Control Methods & Materials	\$111,000	10,000	\$12,000
Elastomeric Sealers for Joints in Concrete Structures	\$20,000	\$10,000	\$ 0,000
Coatings Performance Survey	\$10,000	\$10,000	
Other Materials Total	\$935,834	\$200,000	\$199,000
Dam Safety Research			
Dynamic Properties of Concrete Research of Long-Time Concrete Studies & NDT Systems for In Situ Evaluation of Concrete	\$335,000	\$50,000	
Behavior of Concrete Dams and Their Foundations During Extreme Seismic Events	\$333,000	\$60,000	\$60,000
Portland Cement GROUTING Research	\$96,000	\$40,000	\$40,000
Chemical Grouts for Dam Foundation Seepage Control	\$323,000	\$50,000	\$30,000
	\$89,000	\$15,000	
Dam Safety Research Total	\$1,176,000	\$215,000	\$130,000
TOAL	\$5,064,834	\$885,000	\$749,000