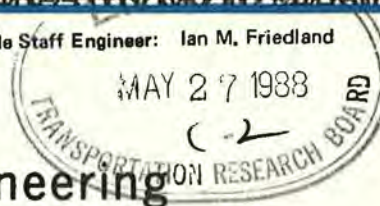


Areas of Interest: 25 structures design and performance, 33 construction, 40 maintenance, 62 soil foundations (1 highway transportation, 2 public transit, 3 rail transportation)

Responsible Staff Engineer: Ian M. Friedland



NCHRP Research on Bridge Engineering

An NCHRP staff digest of the progress and status of bridge engineering research under the National Cooperative Highway Research Program.

Since its inception in 1962, the National Cooperative Highway Research Program (NCHRP) has included numerous studies of interest to bridge engineers. In recent years, there has been a growing national awareness of bridge problems, and a substantial number of bridge research projects have been referred to the NCHRP by the program sponsors, the American Association of State Highway and Transportation Officials (AASHTO). In fact, since 1980, more than one-third of the NCHRP's funds have been allocated for studies of problems in the area of bridge engineering.

Many of these studies have been directed toward development of improved methods of design and construction, with the ultimate goal of modifying the AASHTO *Standard Specifications for Highway Bridges*. In the early- to mid-1980's, the focus of NCHRP research shifted toward solving problems in evaluation, repair, or rehabilitation of existing bridges. More recently, NCHRP's bridge research has included numerous projects that will result in

recommended revisions to major sections of the AASHTO bridge specifications, incorporating the results of the bridge research completed during the last decade.

AASHTO DESIGN SPECIFICATIONS

Since initial adoption more than 50 years ago, the AASHTO *Standard Specifications for Highway Bridges* has been modified annually by the AASHTO Highway Subcommittee on Bridges and Structures. These specifications are relied upon by engineers in state highway agencies, consulting firms, and other organizations responsible for design, construction, and maintenance of bridges. Because of the piecemeal development of the current specifications, extra care is required to avoid inconsistencies, fragmentation, and internal conflicts as individual sections of the specifications are revised each year. This problem is compounded by the fact that a comprehensive commentary is not available to record the origin and clarify the intent of key provisions of the specifications.

At the request of the AASHTO Highway Subcommittee on Bridges and Structures, research was initiated on NCHRP Project 12-33 in mid-1988 with the objective of developing recommended bridge design specifications and commentary that can be considered for adoption by the Subcommittee. The new specifications, based on the load and resistance factor design (LRFD) philosophy, are expected to draw heavily from recent developments in bridge design practice throughout the world as well as from recently completed and current bridge research. It is estimated that completely new LRFD-based bridge specifications and a commentary can be developed in 42 months at an estimated cost of \$1.6 million.

CONSTRUCTION

Several other major specification-related studies were also requested by the AASHTO Highway Subcommittee on Bridges and Structures. NCHRP Project 12-34, "Update of AASHTO *Standard Specifications for Highway Bridges*: Division II-- Construction," was initiated in late 1987 with the objective of providing a complete overhaul to the present Division II--Construction specification in the AASHTO *Standard Specifications*. These specifications should reflect the latest state of the art in proven construction practice. As technology changes, it is important to have these changes reflected in the specifications. The changes that have occurred in Division II over the years have also been made on a piecemeal basis and no longer reflect current bridge construction practice. As a result, less than one-half of the states presently use the current Division II specification. NCHRP Project 12-34 will provide the basis for the required updating.

INSPECTION AND EVALUATION

The AASHTO *Manual for Maintenance Inspection of Bridges* is intended as a guide to provide uniformity in inspection and evaluation techniques for all

bridges on public roads. Since the *Manual* was initially adopted by AASHTO in 1970, only minor changes and additions have been made to it. Many subsequent advances in analytical and practical techniques are being used in bridge design, construction, and evaluation, but they have not been reflected in the *Manual*.

NCHRP Project 12-23, "Recommended Revisions to the AASHTO *Manual for Maintenance Inspection of Bridges*," will start near the end of 1988. The objective of the project is to develop a revised *Manual for Maintenance Inspection of Bridges* that can be recommended to AASHTO for consideration for adoption. A thorough review and revision of the inspection and evaluation criteria that is based on current technology and recently completed and ongoing research will result in a better assessment of the condition and load capacity of existing bridges.

THIS DIGEST

This *Results Results Digest* supersedes Research Results Digest 155 published in February 1986. The purpose of the Digest is to outline for easy reference (see Tables 1 through 5) the status of, and inter-relationships between, all NCHRP research related to bridges. Included are projects under development, in progress, and completed. A listing of all related research reports is also provided.

Table 1 lists all NCHRP bridge engineering projects currently in progress. At the present time, more than 30 bridge-related studies are underway with a total research funding of more than \$10 million. Included in Table 1 are the previously described NCHRP Projects 12-33 and 12-34. Details on each of the projects in this table can be found in the NCHRP *Summary of Progress Through 1987*.

Research projects in the developmental stage or expected to start in the near future are covered in Table 2.

NCHRP Project 12-23, described above, is included in this table.

Table 3 provides a cross-reference between pending, active, and recently completed NCHRP research projects and the previously described studies (NCHRP Projects 12-23, 12-33, and 12-34) relevant to bridge design, construction, and inspection and rating. In some cases, individual NCHRP projects will produce results related to more than one specification. For example, NCHRP Project 10-20 on elastomeric bearings will produce recommendations for changes to both the design specifications and construction specifications.

A chronological arrangement of all NCHRP publications on bridge research is provided in Table 4. Some 68 relevant publications in the NCHRP Report Series are contained in Table 4(a). Several of the earlier reports are included for the sake of completeness, and should no longer be considered to be thorough, up-to-date treatments of the subject matter. NCHRP Syntheses of Highway Practice that are concerned with bridge problems are listed in Table 4(b). These reports emanate from NCHRP Project 20-5, "Synthesis of Information Related to Highway Problems." Table 4(c) includes NCHRP Research Results Digests on studies of bridge problems.

Table 5 summarizes the availability of uncorrected agency final reports

which have not been published by the NCHRP.

OBTAINING PUBLICATIONS

Copies of the publications in Table 4 and microfiche of the uncorrected agency reports listed in Table 5 can be obtained from the Publications Office, Transportation Research Board, 2101 Constitution Avenue, NW, Washington, DC 20418. A check or money order payable to the *Transportation Research Board* must accompany orders totaling \$20.00 or less.

NCHRP research covers a wide range of problem areas related to design, construction, and maintenance of bridges. Nevertheless, the studies included in Tables 1 through 5 comprise only a small portion of all bridge research carried out in the United States in recent years. A more comprehensive listing of current and planned research, including FHWA-sponsored contracts and state Highway Planning and Research (HP&R) studies, can be found in the documentation for the FHWA's Nationally Coordinated Program of Highway Research, Development, and Technology (NCP), which may be obtained from the office of Mr. Charles F. Galambos, Chief, Structures Division, Office of Research, Development & Technology, HNR-10, Federal Highway Administration, 6300 Georgetown Pike, McLean, Va 22101 (703/285-2087).

TABLE 1 - RESEARCH IN PROGRESS

Project Number	Title	Research Agency	Completion Date
2-16	Relationships Between Vehicle Configurations and Highway Design	Transportation Research Board	3/90
3-36	Development of a Low-Cost Bridge Weigh-In-Motion System	Bridge Weighing Systems, Inc.	8/89
3-39	Evaluation and Calibration Procedures for Weigh-In-Motion Systems	Texas A & M University	12/90
4-15	Corrosion Protection of Prestressing Systems in Concrete Bridges	Wiss, Janney, Elstner Assoc.	*
10-13/1	Ultrasonic Measurement of Weld Flaw Size	The Welding Institute (UK)	*
10-20/2	Elastomeric Bearings Design, Construction, and Materials	University of Washington	6/89
10-22/1	The Performance of Weathering Steel in Bridges	Sheladia Associates, Inc.	*
10-29	Anchorage Zone Reinforcement for Post-Tensioned Concrete Girders	University of Texas at Austin	10/89
10-30(3)	Nondestructive Methods for Field Inspection of Embedded or Encased High Strength Steel Rods and Cables	University of Manchester (UK)	10/89
10-31	Acceptance Criteria for Steel Bridge Welds	Materials Research Laboratory	1/89
10-35	Fatigue Behavior of Welded and Mechanical Splices in Reinforcing Steel	Wiss, Janney, Elstner Assoc.	5/90
10-36	Evaluation of Weldments Incorporating Backing Materials	Arctec Canada Limited	5/91
12-15(5)	Fatigue Behavior of Variable Loaded Bridge Details Near the Fatigue Limit	Lehigh University	1/90
12-18A	Assessment of an Integrated Bridge Design System	Engineering Computer Corp.	*
12-26	Distribution of Wheel Loads on Highway Bridges	Imbsen & Associates, Inc.	*
12-27	Welded Repair of Cracks in Steel Bridge Members	The Welding Institute (UK)	8/88
12-28(1)	Load Capacity Evaluation of Existing Bridges	Case Western Reserve Univ.	9/89
12-28(2)/1	Bridge Management Systems	ARE, Inc.	11/89
12-28(6)	Distortion Induced Fatigue Cracking in Steel Bridges	Lehigh University	10/88
12-28(7)	Guidelines for Evaluating Corrosion Effects in Existing Steel Bridges	Modjeski and Masters	2/89
12-28(10)	Guidelines for Determining Redundancy in Steel Bridges	Lehigh University	9/88
12-28(11)	Development of Site-Specific Load Models for Bridge Rating	Imbsen & Associates, Inc.	2/89
12-28(12)	Inelastic Rating Procedures for Steel Beam and Girder Bridges	University of Minnesota	12/89
12-28(13)	Nondestructive Load Testing for Bridge Evaluation and Rating	Raths, Raths, & Johnson, Inc.	4/89
12-29	Design of Simple-Span Precast Prestressed Bridge Girders Made Continuous	Construction Technology Laboratories/PCA	*
12-30	Fatigue of Cables in Cable-Stayed Bridges	Acer/Freeman Fox Ltd.	8/88
12-31	Notch Toughness Variability in Bridge Steel Plates	University of Texas at Austin	3/90
12-33	Development of a Comprehensive Bridge Specification and Commentary	Modjeski and Masters	1/92
12-34	Update of AASHTO <u>Standard Specifications for Highway Bridges: Division II - Construction</u>	Imbsen & Associates, Inc.	10/89
12-35	Recommended Specifications for the Design of Foundations, Retaining Walls, and Substructures	D'Appolonia	7/89
15-11	Computer-Aided Analysis of Highway Encroachments on Mobile Boundary Streams	Simons & Associates, Inc.	4/90
17-8	Traffic Barrier and Control Treatments for Restricted Work Zones	Texas A & M University	6/91
20-5	Synthesis of Information Related to Highway Problems Topic 16-01, Bridge Inspection Practices - Equipment, Staffing, and Safety Topic 18-03, Bridge Approach Design and Construction Practices Topic 18-04, Treatment of Problem Foundations for Highway Embankments Topic 19-01, Computer-Aided Design and Drafting Systems	Transportation Research Board	Varies
24-3	Laboratory Evaluation of Piles Installed with Vibratory Drivers	University of Houston	9/88
24-4	Load Factor Design Criteria for Highway Structure Foundations	Virginia Tech	6/90

* Final report in review.

TABLE 2 - PENDING RESEARCH

Project Number	Title	Funds Available	Expected Start
10-20	Elastomeric Bearings Design, Construction, and Materials (Phase IV)	250,000	Early 1989
10-29	Anchorage Zone Reinforcement for Post-Tensioned Concrete Girders (Phase II)	250,000	Late 1988
12-23	Recommended Revisions to the AASHTO <u>Manual for Maintenance Inspection of Bridges</u>	200,000	Early 1989
12-26	Distribution of Wheel Loads on Highway Bridges (Phase II)	200,000	Late 1988
22-7	Update of "Recommended Procedures for the Safety Performance Evaluation of Highway Appurtenances"	200,000	Early 1989
22-8	Evaluation of Performance Level Selection Criteria for Bridge Railings	200,000	Early 1989
20-5	Synthesis of Information Related to Highway Problems		
	Topic 20-07 - Concrete Bridge-Deck Removal Procedures		
	Topic 20-09 - Removal of Toxic Paints from Bridges		
	Topic 20-10 - Repair and Replacement of Highway Culverts		
	Topic 20-12 - Latex-Modified Concrete		
	Topic 20-19 - Surface Preparation for Concrete Repairs		
20-7	Research for AASHTO Standing Committee on Highways		
	Task 34 - AASHTO/AWS Bridge Welding Code		
24-5	Downdrag on Bitumen-Coated Piles	200,000	Mid 1988

TABLE 3 - PENDING, ACTIVE, AND RECENTLY COMPLETED NCHRP RESEARCH PROJECTS AND THEIR EFFECTS ON AASHTO BRIDGE SPECIFICATIONS

Project	Description	Design ^a	Construction ^b	Inspection/Rating ^c
10-20	Elastomeric bearings (unconfined and pot)	X	X	
10-22	Weathering steel	X		
10-29	Post-tensioned girder anchorage zone	X		
10-35	Fatigue strength of rebar splices	X		
10-36	Fatigue evaluation of backing bar weldments	X		
12-15(5)	High-cycle variable amplitude fatigue	X		
12-25	Fatigue and fracture of riveted steel bridges			X
12-26	Wheel load distribution	X		X
12-28(1)	Load capacity evaluation of existing bridges			X
12-28(3)	Fatigue evaluation and design procedures	X		X
12-28(5)	Inspection of reinforced concrete bridge components			X
12-28(6)	Distortion induced fatigue evaluation and repair	X	X	X
12-28(7)	Evaluation of corrosion			X
12-28(10)	Redundancy	X		X
12-28(11)	Site-specific load models for bridge evaluation			X
12-28(12)	Inelastic rating for steel girder bridges			X
12-28(13)	Nondestructive load testing			X
12-29	Simple-span precast girder connections	X	X	
12-30	Cable fatigue in cable-stayed bridges	X		
12-31	Notch toughness variability in bridge steels	X		X
12-32	Bridge deck protection		X	
12-35	Update of existing foundation and substructure specifications	X		
20-7/32	Segmental bridge specifications	X	X	
22-8	Bridge railing	X		
24-3	Piles installed with vibratory drivers		X	
24-4	Load factor design for foundations, substructures, and retaining walls	X		
24-5	Downdrag on piles	X		

^a Projects that will provide input into NCHRP Project 12-33 (LRFD-based specification and commentary)

^b Projects that will provide input into NCHRP Project 12-34 (Update construction specifications)

^c Projects that will provide input into NCHRP Project 12-23 (Revision of Manual for Maintenance Inspection)

TABLE 4 - AVAILABLE NCHRP SERIES PUBLICATIONS

No.	Title	Proj.	Research Agency	Pgs.	Cost	Year
(a) NCHRP Reports						
1	Evaluation of Methods of Replacement of Deteriorated Concrete in Structures	6-8	Bertram D. Tallamy Associates	56	*	1964
4	Non-Chemical Methods of Snow and Ice Control on Highway Structures	6-2	Roy Jorgensen and Associates	74	*	1964
16	Protective Coatings to Prevent Deterioration of Concrete by Deicing Chemicals	6-3	Battelle Memorial Institute	21	*	1965
23	Methods for Reducing Corrosion of Reinforcing Steel	6-4	Battelle Memorial Institute	22	*	1966
74	Protective Coatings for Highway Structural Steel	4-6	Steel Struc. Painting Council	64	2.80	1969
74A	Protective Coatings for Highway Structural Steel--Literature Survey	4-6	Steel Struc. Painting Council	275	*	1969
74B	Protective Coatings for Highway Structural Steel--Current Highway Practices	4-6	Steel Struc. Painting Council	102	*	1969
80	Oversize-Overweight Permit Operation on State Highways	2-10	Roy Jorgensen and Associates	120	*	1969
83	Distribution of Wheel Loads on Highway Bridges	12-2	Iowa State University	56	*	1970
86	Tentative Service Requirements for Bridge Rail Systems	12-8	Texas A & M University	62	*	1970
90	Protection of Steel in Prestressed Concrete Bridges	12-5	University of Denver	86	4.00	1970
101	Effect of Stress on Freeze-Thaw Durability of Concrete Bridge Decks	6-9	University of Illinois	70	*	1970
102	Effect of Weldments on the Fatigue Strength of Steel Beams	12-7	Lehigh University	114	5.40	1970
105	Dynamic Pavement Loads of Heavy Highway Vehicles	15-5	General Motors Corporation	94	*	1970
106	Revibration of Retarded Concrete for Continuous Bridge Decks	18-1	University of Illinois	67	*	1970
109	Elastomeric Bearing Research	12-9	Battelle Memorial Institute	53	*	1970
116	Structural Analysis and Design of Pipe Culverts	15-3	Northwestern University	155	*	1971
141	Changes in Legal Vehicles Weights and Dimensions: Some Economic Effects on Highways	19-3	Wilbur Smith and Associates	184	*	1973
147	Fatigue Strength of Steel Beams with Welded Stiffeners and Attachments	12-7	Lehigh University	85	4.80	1974
149	Bridge Rail Design--Factors, Trends, and Guidelines	12-8	Texas A & M University	49	4.00	1974
153	Recommended Procedures for Vehicle Crash Testing of Highway Appurtenances	22-2	Southwest Research Institute	19	3.20	1974
163	Design of Bent Caps for Concrete Box-Girder Bridges	12-10	Portland Cement Association	124	6.80	1976
164	Fatigue Strength of High-Yield Reinforcing Bars	4-7	Portland Cement Association	90	5.60	1976
165	Waterproof Membranes for Protection of Concrete Bridge Decks--Laboratory Phase	12-11	Materials Research and Development	70	4.80	1976
180	Cathodic Protection for Reinforced Concrete Bridge Decks	12-13	USS Engineers and Consultants	135	*	1977
181	Subcritical Crack Growth in Steel Bridge Members	12-14	U. S. Steel Corporation	82	5.60	1977
182	Economic Evaluation of Ice and Frost	6-11	Midwest Research Institute	73	4.80	1978
188	Fatigue of Welded Steel Bridge Members Under Variable Amplitude Loadings	12-12	U. S. Steel Corporation	113	6.40	1978
190	Use of Polymers in Highway Concrete	18-2	Lehigh University	77	*	1978
198	State Laws and Regulations on Truck Size and Weight	20-16	R. J. Hansen Associates	117	7.20	1979
201	Acceptance Criteria for Electroslag Weldments in Bridges	10-10	U. S. Steel Corporation	44	5.20	1979
203	Safety at Narrow Bridge Sites	20-7	Texas A&M University	63	6.00	1979
204	Bridge Deck Joint-Sealing Systems--Evaluation and Performance Specification	(Task 7) 10-11	Howard Needles Tammen & Bergendoff	46	5.60	1979
206	Detection and Repair of Fatigue Damage in Welded Highway Bridges	12-15 & 12-15(2)	Lehigh University	85	6.80	1979
222	Bridges on Secondary Highways and Local Roads--Rehabilitation and Replacement	12-20	University of Virginia	132	9.20	1980
226	Damage Evaluation and Repair Methods for Prestressed Concrete Bridge Members	12-21	G. O. Shanafelt & W. B. Horn	66	7.20	1980
227	Fatigue Behavior of Full-Scale Welded Bridge Attachments	12-15(3)	Lehigh University	47	6.40	1980
230	Recommended Procedures for the Safety Performance Evaluation of Highway Appurtenances	22-2(4)	Southwest Research Institute	42	6.00	1981
234	Galvanic Cathodic Protection for Reinforced Concrete Bridge Decks--Field Evaluation	12-13A	Portland Cement Association	64	6.80	1981
239	Multiple-Service-Level Highway Bridge Railing Selection Procedures	22-2(3)	Southwest Research Institute	161	10.40	1981
240	A Manual to Determine Benefits of Separating Pedestrians and Vehicles	20-10(2)	SRI International	56	7.20	1981
242	Ultrasonic Measurement of Weld Flaw Size	10-13	The Welding Institute (UK)	76	8.00	1981
243	Rehabilitation and Replacement of Bridges on Secondary Highways and Local Roads	12-20	University of Virginia	46	6.80	1981

TABLE 4 - Continued

No.	Title	Proj.	Research Agency	Pgs.	Cost	Year
(a) NCHRP Reports, Continued						
244	Concrete Sealers for Protection of Bridge Structures	12-19A	Wiss, Janney, Elstner & Assoc.	138	10.00	1981
248	Elastomeric Bearings Design, Construction, and Materials	10-20	University of Washington	82	8.40	1982
251	Assessment of Deficiencies and Preservation of Bridge Substructures Below the Waterline	10-16	Byrd, Tallamy, MacDonald and Lewis	80	8.40	1982
257	Long-Term Rehabilitation of Salt-Contaminated Bridge Decks	18-2(3)	Lehigh University	32	6.40	1983
265	Removal of Lead-Based Bridge Paints	10-23	Midwest Research Institute	72	8.00	1983
267	Steel Bridge Members Under Variable Amplitude Long Life Fatigue Loading	12-15(4)	Lehigh University	26	6.40	1983
271	Guidelines for Evaluation and Repair of Damaged Steel Bridge Members	12-17A	G. O. Shanafelt and W. B. Horn	64	7.60	1984
272	Performance of Weathering Steel in Bridges	10-22	Sheladia Associates, Inc.	164	12.00	1984
276	Thermal Effects in Concrete Bridge Superstructures	12-22	Engineering Computer Corp.	99	9.60	1985
278	Cathodic Protection of Concrete Bridge Substructures	12-19B	Wiss, Janney, Elstner Assoc.	60	8.40	1985
280	Guidelines for Evaluation and Repair of Prestressed Concrete Bridge Members	12-21(1)	G. O. Shanafelt and W. B. Horn	84	9.20	1985
286	Evaluation of Fatigue Tests and Design Criteria on Welded Details	12-15(5)	Lehigh University	66	8.40	1986
287	Load Distribution and Connection Design for Precast Stemmed Multibeam Bridge Superstructures	12-24	University of Washington	137	11.80	1986
289	Performance of Longitudinal Traffic Barriers	22-4	Southwest Research Institute	169	13.20	1987
290	Reinforcement of Earth Slopes and Embankments	24-2	Dames & Moore	323	40.00	1987
292	Strength Evaluation of Existing Reinforced Concrete	10-15/1	Engineering Computer Corp.	133	14.00	1987
293	Methods of Strengthening Existing Highway Bridges	12-28(4)	Iowa State University	114	12.00	1987
297	Evaluation of Bridge Deck Protective Strategies	12-32	University of Washington	80	12.00	1987
298	Performance of Elastomeric Bearings	10-20/1	University of Washington	100	12.00	1987
299	Fatigue Evaluation Procedures for Steel Bridges	12-28(3)	Case Western Reserve Univ.	94	11.20	1987
300	Bridge Management Systems	12-28(2)	ARE, Inc.	74	10.40	1987
301	Load Capacity Evaluation of Existing Bridges	12-28(1)	Case Western Reserve Univ.	104	11.60	1987
302	Fatigue and Fracture Evaluation for Rating Riveted Bridges	12-25	Lehigh University	**	**	1987
304	Condition Surveys of Concrete Bridge Components	12-28(5)	New Mexico State University	**	**	1987
306	Correlation of Bridge Load Capacity Estimates with Test Data	12-28(8)	University of Tennessee	**	**	1988
(b) NCHRP Synthesis of Highway Practice (Project 20-5)						
2	Bridge Approach Design and Construction Practices	Topic #2	Transportation Research Board	30	*	1969
4	Concrete Bridge Deck Durability	#3	Transportation Research Board	28	*	1970
5	Scour at Bridge Waterways	#5	Transportation Research Board	28	*	1970
33	Acquisition and Use of Geotechnical Information	#5-04	Transportation Research Board	40	4.00	1976
41	Bridge Bearings	#6-09	Transportation Research Board	62	*	1977
42	Design of Pile Foundations	#5-04	Transportation Research Board	68	4.80	1977
44	Consolidation of Concrete for Pavements, Bridge Decks, and Overlays	#7-01	Transportation Research Board	61	4.80	1977
50	Durability of Drainage Pipe	#5-09	Transportation Research Board	37	3.60	1978
53	Precast Concrete Elements for Transportation Facilities	#8-05	Transportation Research Board	48	5.60	1978
57	Durability of Concrete Bridge Decks	#9-01	Transportation Research Board	61	*	1979
67	Bridge Drainage Systems	#10-06	Transportation Research Board	44	5.60	1979
68	Motor Vehicle Size and Weight Regulations, Enforcement, and Permit Organizations	#10-04	Transportation Research Board	45	6.00	1980
78	Value Engineering in Preconstruction and Construction	#11-02 & #11-03	Transportation Research Board	23	6.40	1981
82	Criteria for Evaluation of Truck Weight Enforcement Programs	#12-02	Transportation Research Board	74	7.20	1981
86	Effects of Traffic-Induced Vibrations on Bridge-Deck Repairs	#10-21	Transportation Research Board	40	6.80	1981
88	Underwater Inspection and Repairs of Bridge Substructures	#10-08	Transportation Research Board	77	7.60	1981
101	Historic Bridges: Criteria for Decision Making	#13-11	Transportation Research Board	84	8.00	1983
107	Shallow Foundations for Highway Structures	#12-06	Transportation Research Board	38	6.80	1983
108	Bridge Weight-Limit Posting Practice	#13-08	Transportation Research Board	30	6.40	1984
111	Distribution of Wheel Loads on Highway Bridges	#14-22	Transportation Research Board	22	7.20	1984
112	Cost-Effectiveness of Hot-Dip Galvanizing for Exposed Steel	#15-19	Transportation Research Board	28	7.20	1984
118	Detecting Defects and Deterioration in Highway Structures	#15-03	Transportation Research Board	52	8.00	1985

TABLE 4 - Continued

No.	Title	Proj.	Research Agency	Pgs.	Cost	Year
(b) NCHRP Synthesis of Highway Practice (Project 20-5), Continued						
119	Prefabricated Bridge Elements and Systems	#15-10	Transportation Research Board	75	8.80	1985
123	Bridge Designs to Reduce and Facilitate Maintenance and Repair	#12-11	Transportation Research Board	65	8.40	1985
124	Use of Weigh-In-Motion Systems for Data Collection and Enforcement	#16-02	Transportation Research Board	34	7.60	1986
127	Use of Fly Ash in Concrete	#16-07	Transportation Research Board	66	8.40	1986
129	Freezing and Thawing Resistance of High-Strength Concrete	#16-05	Transportation Research Board	31	7.60	1986
136	Protective Coatings for Bridge Steel	#15-09	Transportation Research Board	**	**	1987
140	Durability of Prestressed Concrete Highway Structures	#15-02	Transportation Research Board	**	**	1988
141	Bridge Deck Joints	#16-10	Transportation Research Board	**	**	1988

(c) NCHRP Research Results Digest

81	Crash Testing and Evaluation of Attenuating Bridge Railing Systems	22-1A	Texas A & M University	10	1.00	1976
85	Bridge Deck Repairs	12-16	Battelle Columbus Laboratory	22	1.00	1976
115	NCHRP Research on the Durability of Reinforced Concrete Bridge Components	Var.	Transportation Research Board	6	1.00	1979
141	Liability of State Highway Departments for Defects in Design, Construction, and Maintenance of Bridges	20-6	Transportation Research Board	30	3.00	1983

Copies of publications listed in Table 4 can be obtained from the Publications Office, Transportation Research Board, 2101 Constitution Avenue, NW, Washington, DC 20418. A check or money order payable to the Transportation Research Board must accompany orders totaling \$20.00 or less.

* Out of print - Available in microfiche from the Transportation Research Board. The cost is \$5.95 per publication.
 ** In publication - Available during 1988.

TABLE 5 - UNCORRECTED AGENCY FINAL REPORTS

Proj. No.	Title	Research Agency	Availability*
4-14	Coating Systems for Painting Old and New Structural Steel	Georgia Institute of Technology	B
10-15	Structural Strength Evaluation of Existing Reinforced Concrete Bridges	Engineering Computer Corporation	B
10-30(1)	Nondestructive Methods for Field Inspection of Embedded or Encased High Strength Steel Rods and Cables	University of Manchester (UK)	A & B
10-30(2)	Nondestructive Methods for Field Inspection of Embedded or Encased High Strength Steel Rods and Cables	Southwest Research Institute	A & B
12-1	Deformation of Steel Beams Related to Permitted Highway Bridge Overloads	University of Missouri	B
12-4	Thermal Characteristics of Highway Bridges	Southwest Research Institute	B
12-6	Prediction of Permanent Camber of Bridges	University of Missouri	B
12-11/1	Waterproof Membranes for Protection of Concrete Bridge Decks	Materials Research & Development	B
12-15	Detection and Repair of Fatigue Cracking in Highway Bridges	Lehigh University	B
12-15(2)	Retrofitting Procedures for Fatigue-Damaged Full-Scale Welded Bridge Beams	Lehigh University	B
12-16	Influence of Bridge Deck Repairs on Corrosion of Reinforcing Steel	Battelle Columbus Laboratories	A & B
12-17	Evaluation of Repair Techniques for Damaged Steel Bridge Members	Battelle Columbus Laboratories	B
12-18	Development of an Integrated Bridge Design System	Multisystems, Inc.	A & B
12-19	Corrosion Control and Repair of Concrete Bridge Structures	Corrosion Eng. & Research Co.	B
12-19	Cathodic Protection of Concrete Bridge Structures	Corrosion Eng. & Research Co.	B
18-2(2)	Polymer Concrete in Highway Bridge Decks	Lehigh University	A & B
20-5	Welding and Inspection Practices in Bridge Fabrication (NCHRP Synthesis of Highway Practice, Topic 9-12)	Carl E. Hartbower	A & B
22-1	Concepts for Improved Traffic Barrier Systems	Walter W. White	B
22-1A	Testing and Evaluation of Bridge Rail Concepts	Texas A&M University	B
22-2(2)	Multiple Service Level Highway Bridge Railings--Performance and Design Criteria (Phase 1)	Southwest Research Institute	B
22-2(2)	Multiple Service Level Highway Bridge Railings--Development and Evaluation of Low-Cost Railing Systems (Phase II)	Southwest Research Institute	B

* A--A copy of the uncorrected draft of the agency's report may be obtained on a loan basis by request to the Director, Cooperative Research Programs, Transportation Research Board.

B--Available in microfiche from the Transportation Research Board. The cost is \$5.95 per publication.