THE NEWS LETTER
OF THE
BUREAU OF PUBLIC ROADS

VOL. 2, NO. 2 DECEMBER, 1926.

CONTENTS

EXTRACTS FROM THE PRESIDENT'S MESSAGE

Extracts from the message of President Calvin C. Coolidge read to the second session of the Sixty-ninth Congress on December 7, 1926.

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"Acting upon my recommendation, the Congress has ordered the Interstate Commerce Commission to investigate the freight-rate structure, directing that such changes shall be made in freight rates as will promote freedom of movement of agricultural products. Railroad consolidation which I am advocating would also result in a situation where rates could be made more advantageous for farm produce, as has recently been done in the revision of rates on fertilizers in the South. Additional benefit will accrue from the development of our inland waterways. The Mississippi River system carries a commerce of over 50,000,000 tons at a saving of nearly $18,000,000 annually. The Inland Waterways Corporation operates boats on 2,500 miles of navigable streams, and through its relation with 165 railroads carries freight into and out of 45 States in the Union. During the past six months it has handled over 1,000,000 bushels of grain monthly and by its lower freight rates has raised the price of such grain to the farmer probably 2½ cents to 3 cents a bushel. The highway system, on which the Federal Government expends about $85,000,000 a year, is of vital importance to the rural regions."

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American Ideals.

"America is not and must not be a country without ideals. They are useless if they are only visionary; they are only valuable if they are practical. A nation can not dwell constantly on the mountain tops. It has to be replenished and sustained through the ceaseless toil of the less inspiring valleys. But its face ought always to be turned upward, its vision ought always to be fixed on high.

We need ideals that can be followed in daily life, that can be translated into terms of the home. We can not expect to be relieved from toil, but we do expect to divest it of degrading conditions. Work is honorable; it is entitled to an honorable recompense. We must strive mightily, but having striven there is a defect in our political and social system if we are not in general rewarded with success. To relieve the land of the burdens that came from the war, to release to the individual more of the

FRUITS OF HIS OWN INDUSTRY, TO INCREASE HIS EARNING CAPACITY AND DECREASE H'S HOURS OF LABOR, TO ENLARGE THE CIRCLE OF HIS VISION THROUGH GOOD ROADS AND BETTER TRANSPORTATION, TO PLACE BEFORE HIM THE OPPORTUNITY FOR EDUCATION BOTH IN SCIENCE AND IN ART, TO LEAVE HIM FREE TO RECEIVE THE INSPIRATION OF RELIGION, ALL THESE ARE IDEALS WHICH DELIVER HIM FROM THE SERVITUDE OF THE BODY AND EXALT HIM TO THE SERVICE OF THE SOUL. THROUGH THIS EMANCIPATION FROM THE THINGS THAT ARE MATERIAL, WE BROADEN OUR DOMINION OVER THE THINGS THAT ARE SPIRITUAL."

CALVIN COOLIDGE.

NEWS LETTER NOT INTENDED FOR GENERAL DISTRIBUTION

(NOT FOR RELEASE)

RECENTLY REQUESTS HAVE BEEN MADE FOR COPIES OF THE NEWS LETTER BY ORGANIZATIONS AND INDIVIDUALS OUTSIDE OF THE BUREAU. CORRESPONDENCE FROM THE FIELD OFFICES ALSO INDICATES THAT COPIES OF THE NEWS LETTER ARE BEING RELEASED TO THE STATE HIGHWAY DEPARTMENTS AS A SOURCE OF INFORMATION FOR STATE HIGHWAY PERIODICALS. IT WAS NOT INTENDED THAT THE NEWS LETTER SHOULD BE DISTRIBUTED IN THIS MANNER AND IT IS, THEREFORE, BELIEVED ADVISABLE TO RESTATE BRIEFLY JUST WHAT PURPOSE THE NEWS LETTER IS DESIGNED TO FULFILL.

THE NEWS LETTER IS INTENDED PRIMARILY TO DEVELOP UNITY OF PURPOSE AND CONCERTED ACTION IN ALL BRANCHES OF THE BUREAU ORGANIZATION AND TO DISSEMINATE INFORMATION WITHIN THE BUREAU. IT IS AIMED TO ACCOMPLISH THESE OBJECTS BY ARTICLES OR REPRINTS OF SPEECHES WHICH INDICATE THE VIEWPOINT OF THE CHIEF OF THE BUREAU, BY ANNOUNCEMENTS OF RESEARCH PROJECTS, BY DESCRIPTIONS OF THE MOST RECENT INNOVATIONS IN HIGHWAY CONSTRUCTION PRACTICES IN THE SEVERAL STATES, AND BY TABLES AND OTHER DATA WHICH INDICATE THE GENERAL TREND OF HIGHWAY DEVELOPMENT. THE NATURE OF THE INFORMATION IS SUCH THAT THE NEWS LETTER BECOMES A BUREAU ORGAN DESIGNED FOR THE IMMEDIATE INFORMATION OF OUR OWN PERSONNEL.

THE NEWS LETTER CONTAINS MATERIAL WHICH IS SUITABLE FOR GENERAL DISTRIBUTION AND ALSO INFORMATION FURNISHED ONLY FOR THE MEMBERS OF THE BUREAU. IN THE FUTURE THOSE ARTICLES WHICH ARE NOT TO BE DISSEMINATED GENERALLY WILL BE MARKED "NOT FOR RELEASE." THE BALANCE OF THE MATERIAL MAY BE RELEASED AT THE DISCRETION OF THE DISTRICT ENGINEERS. IT IS DESIRED THAT RELEASES FROM THE TEXT SHALL BE GIVEN OUT IN THE FORM OF TYPEWRITTEN COPIES OF THE NEWS LETTER INFORMATION. THE ORIGINAL MIMEOGRAPHED SHEETS OF THE PERIODICAL ARE NOT EXPECTED TO BE RELEASED. IF FOUND MORE PRACTICABLE, APPROVED TABLES, CHARTS OR DIAGRAMS MAY BE SEPARATED FROM THE NEWS LETTER AND GIVEN OUT IN THEIR ORIGINAL FORM.

CONCRETE PAVEMENT DESIGN

CONTRIBUTED BY THE DIVISION OF DESIGN

(~~TEXT~~ NOT FOR RELEASE)

FOR THE PURPOSE OF COMPARING AND STUDYING THE VARIOUS CEMENT CONCRETE PAVEMENT DESIGNS SUBMITTED BY THE STATES FOR FEDERAL-AID ROAD WORK, A TABULATED RECORD OF THE PRINCIPAL FEATURES, BASED ON 1926 PRACTICE, HAS BEEN PREPARED BY THE DIVISION OF DESIGN.

EFFORT WAS MADE TO ELIMINATE, SO FAR AS POSSIBLE, SUCH DESIGNS AS APPEARED TO BE UNUSUAL AND TO SELECT FOR STUDY THE DESIGN MOST REPRESENTATIVE OF THE USUAL PRACTICE IN EACH STATE. CERTAIN STATES HAVE DEVELOPED STANDARD DESIGNS WHICH ARE APPARENTLY USED WITHOUT VARIATION, WHILE OTHER STATES VARY SUCH FEATURES AS DEPTH OF PAVEMENT, MIX, AMOUNT AND POSITION OF STEEL REINFORCEMENT, SPACING OF TRANSVERSE JOINTS AND EVEN THE SHAPE OF THE CROSS SECTION, TO FIT LOCAL CONDITIONS ON EACH PROJECT. IN FOUR STATES SO FEW PROJECTS INVOLVING CONCRETE PAVEMENTS HAVE BEEN RECEIVED THAT NO GENERAL IDEA OF THEIR PRACTICE IN DESIGNING COULD BE OBTAINED.

IN ORDER TO PERMIT QUICK AND EASY COMPARISON OF THE DESIGNS SELECTED AS FAIRLY REPRESENTATIVE OF PRACTICE IN EACH STATE, THE DATA OBTAINED IN THE STUDY HAVE BEEN COMPILED IN THE FORM OF TABLES, WHICH ARE REPRODUCED HEREWITH. ACCOMPANYING THE TABLES IS A SERIES OF SKETCHES OF SOME OF THE UNIQUE AND INTERESTING FEATURES OF DESIGN FOUND IN CERTAIN STATES.

A CASUAL EXAMINATION OF THE TABLES SHOWS THAT THE THICKENED-EDGE SECTION HAS BEEN ADOPTED BY A GREAT MAJORITY OF THE STATES BUT THERE IS LITTLE UNIFORMITY IN THE METHOD OF DEVELOPING THE SECTION. OF THE SEVEN STATES USING THE UNIFORM-THICKNESS DESIGN, IT IS INTERESTING TO NOTE THAT FOUR ARE NEW ENGLAND STATES, THE OTHERS BEING NEW JERSEY, NORTH CAROLINA AND WEST VIRGINIA. THE ENGINEERS IN THE NEW ENGLAND STATES CLAIM THAT THE HARD, ROCKY, SOIL CONDITIONS MAKE IT VERY DIFFICULT TO SHAPE THE SUBGRADE FOR THE THICKENED-EDGE SECTION. THESE STATES ALSO USE GRAVEL SUBBASE UNDER THEIR CONCRETE PAVEMENTS AND CONSIDERABLE REINFORCING STEEL WHICH, THEY CLAIM, ELIMINATES TO A GREAT EXTENT THE NECESSITY FOR A THICKENED EDGE. NORTH CAROLINA USES THE UNIFORM SECTION ONLY IN REINFORCED DESIGN. MARYLAND IS THE ONLY STATE WHICH NOW USES A THIN EDGE, THICKENED-CENTER DESIGN.

THE TABLES SHOW A SURPRISING LACK OF UNIFORMITY IN THE AMOUNT OF CROWN USED IN THE VARIOUS STATES FOR CONCRETE PAVEMENTS. THE AMOUNT OF CROWN ON ALL TYPES OF PAVEMENT HAS BEEN MATERIALLY

UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF PUBLIC ROADS

General features of design of cross section of concrete pavements in 1926

State	Pavement cross section						Mix	Reinforced type				Plain type
	Width	Thickness			Thickened-edge width	Crown		Bars	Mesh	Location	Edge bars	
		Edge	Center	Edge								
	Feet	Inches	Inches	Inches	Feet	Inches	Proportions	Pounds per 100 square feet	Pounds per 100 square feet		Number and diameter	
Alabama	18	9	6	9	3	2-curved	1:2:3					No steel
Arizona	18	9	6	9	2	1-1/8-curved	1:2:3½					Dowels only.
Arkansas	18	9	6	9	2	2-1/4- do	do					Two 3/4-inch diam. smooth edge bars.
California	20	9	6-9-6	9	3	1- do	1:2:4(approx.)					Four 3/4-inch diam. deformed edge bars.
Colorado	18	9	6½	9	3	1-1/2-parabolic	1:2:3					Dowels only
Connecticut	18-20	8	8	8	-	2-1/4-circular	1:1½:3½ or 1:2:3½	56 to 63		Top or bottom		
Delaware	18	8	6	8	circular	2- do	1:2:4(A)					Dowels only
Florida	18	9	6	9	3	2-1/4-curved	1:2:4 or 1:2:3½		40	2 inches from top		do do
Georgia	18	9	6	9	3	1-1/2- do	1:2:3½		44	do		No steel.
Idaho	18	8	6	8	2	1- do	1:2:3					Dowels only.
Illinois	18	9	6	9	3	2-circular	1:2:3½					Two 3/4-inch diam. smooth edge bars painted or oiled.
Indiana	18	9	7	9	2½	2-curved	1:2:3					Two 3/4-inch diam. smooth edge bars painted or oiled.
Iowa	18	10	7	10	2	2- do	1:1½:3 to 1:2:3½					Four 5/8-inch diam. edge bars.
Kansas	18	9	6	9	4	2-parabolic	1:2:3½					Four 3/4-inch diam. smooth edge bars.
Kentucky	16	9	6	9	2	2-curved	do	42-alternate types	40(alt. types)	2 inches from top		Two 3/4-inch diam. smooth edge bars painted or oiled.
Louisiana	20	9	6	9	2	2-1/2-curved	do		58	do		
Maine	20	9	7	9	4	1-1/2- do	do	91		5 inches from top		
Maryland	15	6	8	6	flat	2-circular	1:2:4(approx.)		22 to 25	2 inches from top		No steel.
Massachusetts	20	8	8	8		2-1/2-circular	1:2:4(B)	95		2 inches from bottom		
Michigan	20	9	7	9	3	2-curved	1:2:3½	90(alt. types)	55(alt. types)	3½ inches from top		Dowels only
Minnesota	18	9	7	9	4	1- do	do					Six 5/8-inch diam. edge bars.
Mississippi	18	9	6	9	2	2-circular	1:2:3					Two 3/4-inch diam. smooth edge bars.
Missouri	18	9	6	9	2	1-1/2-curved	1:1½:3 to 1:2:3½					Two 3/4-inch diam. smooth edge bars painted or oiled.
Montana	-	-	-	-	-	-	-	-	-	-	-	-
Nebraska	18	9	6	9	3	1-1/2-curved	1:1½:3					Corner bars. 3/4-inch diam.
Nevada	-	-	-	-	-	-	-	-	-	-	-	-
New Hampshire	18	9	6	9	2	2-curved	1:2:3(approx.)		66	2 inches from top		
New Jersey	20	8	8	8		2-parabolic	1:1¼:3½ to 1:1½:3	23 to 80(alt.types)	26.4 to 72.2(alt.types)	Top and bottom		
New Mexico	18	9	6	9	2	1-15/32-parabolic	1:2:3(approx.)		25	2 inches from top		No steel
New York	18	7	6	7	9	1-1/8-straight	1:1½:3	80(alt.types)	45(alt.types)	do	4-½-inch diam.	
North Carolina	16-18	6	6	6 rein.		2-parabolic	1:1½:3 to 1:2:4	72 to 74	63 to 65	2½ inches from top	4-¾-inch diam.	Dowels only
		8	6	8 plain	parabolic			47		2½ inches from bottom		
North Dakota	20	9	6	9	3	3-1/5-circular	1:2:3½	As shown	56(alt.types)	2 inches from top		Two 3/4-inch diam. smooth edge bars painted or oiled.
Ohio	18	9	7	9	2	1-3/4-curved	1:2:3	32		4 inches from top		Dowels only.
Oklahoma	18	9	6	9	2	2- do	1:2:3½					do do
Oregon	20	9	7	9	3	1-1/2 do	1:2:3(approx.)	32 to 45		2 inches from top		
Pennsylvania	20	8	6	8	curved	2-circular	do		42	do		
Rhode Island	18	8	8	8		2-curved	do		25	do		No steel.
South Carolina	18	8	6½	8	paraolic	2-parabolic	1:2:4	-	-	-	-	-
South Dakota	-	-	-	-	-	-	-		44	As shown		Dowels only.
Tennessss	20	8	6	9	curved	1-3/4-parabolic	1:2:3½			2 inches from top		do do
Texas	18	9	6	9	2	1½ to 2½-curved	do	As shown on plans		As shown on plans		Two 3/4-inch square edge bars.
Utah	18	9	6	9	2	1-curved	1:2:3(approx.)					
Vermont	18	7	7	7		2- do	1:2:4	40½		Top and bottom		
Virginia	18	8	6	8	curved	2-1/4-curved	1:2:4(approx.)					No steel.
Washington	20	9	6½	9	2	1-1/2- do	1:2:3					Dowels only.
West Virginia	18	7	7	7		2-1/4-parabolic	1:1½:3½ to 1:2:3½					No steel.
Wisconsin	20	9	6½	9	4	1-curved	1:2:4(approx.)					Dowels only.
Wyoming	-	-	-	-	-	-	-	-	-	-	-	-

Admixtures: A-0.1 cu. ft. of hydrated lime per bag of cement.
B-0.08 do do do do do do do do do .

UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF PUBLIC ROADS

General features of design of joints in concrete pavements in 1926

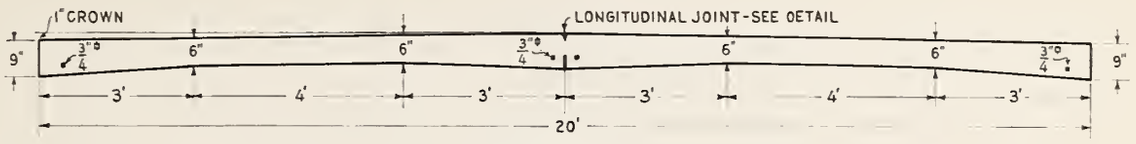
State	Longitudinal joint		Transverse joint				Dowels		Special features
	Type	Gauge or width.	Type	Spacing	Width	Filler	Longitudinal joints	Transverse joints	
		Number or inches		Feet	Inches				
Alabama	Not required		Expansion	40	3/8	Prepared bituminous		None	
Arizona	As shown on plans		do	40	5/8	do	1/2-inch diam., 5 ft. c.to c.	do	
Arkansas	do		do	50	1/2	Prepared or poured bit.	4 ft. by ½-inch diam.. deformed, 5 ft. c. to c.	Two-4 ft. by 1/2-inch diam.	
California	Submerged. See sketch		do	50	1/2 to 3/4	do	None	Ten-2 ft. by 3/4-inch diam., smooth. one end free	See sketch for longitudinal joint and cross section
Colorado	Deformed metal plate	18	do	60	1/2	Prepared bituminous	4 ft.by ½-inch diam.. smooth, 5 ft. c. to c.	None	
Connecticut	Prepared or poured bituminous	1/4	do	40	1/2	Prepared or poured bit.	None	None	Reinforcing in top on cuts, in bottom on fills
Delaware	Deformed metal plate	16	Construction	Necessary			4 ft.by ½-inch diam., deformed. 5 ft. c. to c.	Seven - 4 ft.by ½-inch diam., smooth, one end free	Admixture of hyurated lime
Florida	Not required		Expansion	40	1/4 to 1/2	Prepared or poured bit.		Size and spacing not shown, one end free	
Georgia	do		do	Necessary	1/2 to 3/4	Poured bituminous		None	See sketch for thickened transverse joint
Idaho	Deformed metal plate	14	do	30	1/4 to 1/2	Prepared bituminous	2 ft.by ½-inch diam.,21 inches c.to c.	do	
Illinois	do	16	Construction	Necessary			4 ft.by ½-inch diam., deformed, 5 ft. c. to c.	do	
Indiana	do	16	do	do			4 ft.by 5/8-inch diam., deformed, 5 ft. c. to c.	Six - 4 ft. by ½-inch diam., smooth, one end free	
Iowa	do	18	do	do			5 ft. by 5/8-inch diam., 4 ft.c.to c.	Nine - 2 ft. by 5/8-inch diam., smooth. one end free	See sketch for cross section.
Kansas	do	18	Expansion	150	3/4	Prepared bituminous	4 ft. by ½-inch diam., deformed, 5 ft. c. to c.	None	Tongue and groove construction joint
Kentucky	do	16	do	30	1/2	do	do	do	
Louisiana	do	16	do	50	1/2	Prepared or poured bit.	do	Seven - 4 ft. by ½-inch diam., smooth, one end free	Half-width construction required
Maine	Poured bituminous filler	Paint Coat	do	40	1/2	Prepared bituminous	2 ft. by ½-inch diam.. smooth, 3-1/3 ft. c. to c. one end free	Eight - 2 ft. by ½-inch diam., smooth one end free	do
Maryland	Not required		Construction	Necessary				None	See sketch - thin edged section
Massachusetts	Poured bituminous filler	Paint Coat	Expansion	60	1/2	Poured bituminous	3-1/3 ft. by 1/2-inch square, deformed, 5 ft. c. to c.	Eight - 4 ft. by ½-inch square smooth, one end free	Half-width construction and admixture
Michigan	Deformed metal plate	16	do	75 to 100	1	Prepared bituminous	5 ft. by ½-inch diam., 5ft.c.to c.	None	
Minnesota	do	16	do	201-2/3	2	do	4 ft. by ½-inch diam., deformed, 5 ft. c. to c.	Six - 2½ ft. by ¾-inch diam., smooth, one end free	See sketch of construction joints
Mississippi	do	18	do	50	1/4 to 1/2	Prepared or poured bit.	do	Ten - 4 ft. by ¾-inch diam., smooth.one end free	
Missouri	do	16	Construction	Necessary			do	None	
Montana	-	-	-	-	-	-	-	-	-
Nebraska	Deformed metal plate	18	Construction	Necessary			4 ft. by ½-inch diam., 5 ft. c.to c.	None	See sketch of thickened, tongue and groove joint
Nevada	-	-	-	-	-	-	-	-	-
New Hampshire	Poured bituminous filler	Paint coat	Expansion	50	1/4 to 3/4	Prepared or poured bit.	None	Eight - 2 ft. by 5/8-inch diam., smooth, one end free	Half-width construction required
New Jersey	Prepared bituminous filler	1/2	do	34-1/3 to 45-1/3	1/2	do	do	Nineteen - ¾-inch diam., smooth, one end free	Double line of reinforcing
New Mexico	As shown on plans		do	30	1/4 to 1/2	Prepared bituminous	When shown	None	
New York	Plain butt joint		do	40	1/2	do	None	None	Half-width construction.see sketch of cross section
North Carolina	Not required		Construction	Necessary				Eight or nine - 4 ft. by ¾-inch diam., one end free	See sketch of drop curbs at pavement ends
North Dakota	Deformed metal plate	Not shown	Expansion	30	1/2	Prepared bituminous	5 ft. by 5/8-inch. diam.		Heavy crown
Ohio	do	18	Construction	Necessary			5 ft. by ½-inch diam., deformed		
Oklahoma	do	18	Expansion	50	1	Poured bituminous	4 ft. by ½-inch diam., 5 ft.c.to c.	None	

General features of design of joints in concrete pavements in 1926 – continued

State	Longitudinal Joint		Transverse Joint				Dowels		Special features
	Type	Gauge or width	Type	Spacing	Width	Filler	Longitudinal joints	Transverse joints	
		Number or inches		Feet	Inches				
Oregon	Deformed metal plate	18	Expansion	25	1/4	Prepared bituminous	3 ft. by 1/2-inch square, deformed, 3 ft. c.to c.	None	
Pennsylvania	do	14	do	Designed	1/2	do	4 ft. by 1/2-inch diam., deformed, 5 ft. c.to c.	do	Expansion joint location predetermined
Rhode Island	Plain butt joint		do	100	1/2	do	2 ft. by 1/2-inch square. 3 ft. c.to c.	Eight - 2 ft. by 1/2-inch diam., smooth, one end free	
South Carolina	Not required		do	40	1/4 to 1/2	do		None	
South Dakota	-	-	-	-	-	-	-	-	-
Tennessee	Deformed metal plate	18	Expansion	30	3/4	Prepared or poured bit.	4 ft. by 1/2-inch diam., 5 ft. c.to c.	None	
Texas	do	18	do	60 to 100	1/4 to 1/2	do	4 ft. by 1/2-inch diam., 3-1/2 to 5 ft. c.to c.	Six - 4 ft. or 5 ft. by 1/2 or 3/4-inch diam., smooth, one end free	
Utah	do	18	do	40	1/4 to 1/2	do	4 ft. by 1/2-inch square. 5 ft. c.to c.	None	Tongue and groove construction joint
Vermont	Poured bituminous filler	Paint coat	do	43-2/3	1/2	do	2 ft. by 3/4-inch diam., deformed, 3-1/3 ft. c.to c.	Eight - 2 ft. by 3/4-inch diam., smooth, one end free	
Virginia	Not required		Construction Necessary					None	
Washington	Poured bituminous filler	1/4	Expansion	60	1/4 to 1/2	Poured bituminous	2 ft. by 1/2-inch square, smooth. 1-1/2 ft. c.to c.	do	See sketch of contraction joint
West Virginia	Deformed metal plate	16	Construction Necessary				None	do	
Wisconsin	do	18	Expansion	31-1/2	1/2	Prepared bituminous	4 ft. by 1/2-inch diam., deformed, 4 ft. c.to c.	Four - 4 ft. by 5/8-inch diam., one end free	
Wyoming	-	-	-	-	-	-	-	-	-

SPECIAL FEATURES OF CONCRETE PAVEMENT DESIGNS FOR 1926

CALIFORNIA



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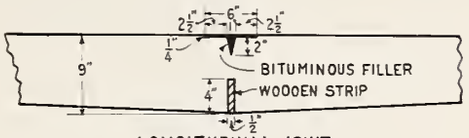
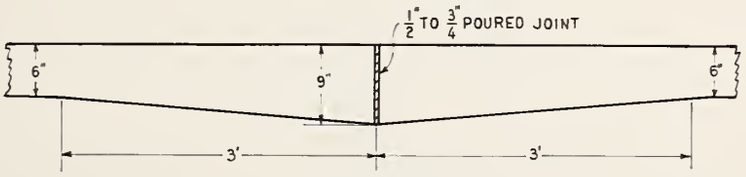


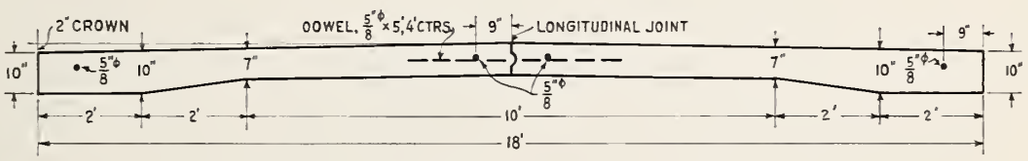
LONGITUDINAL JOINT

GEORGIA



TRANSVERSE JOINT

IOWA



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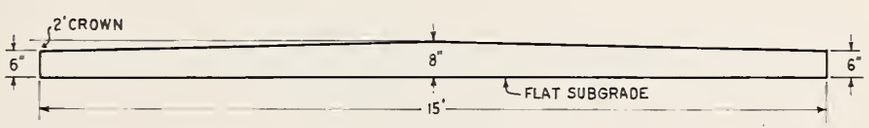
MARYLAND



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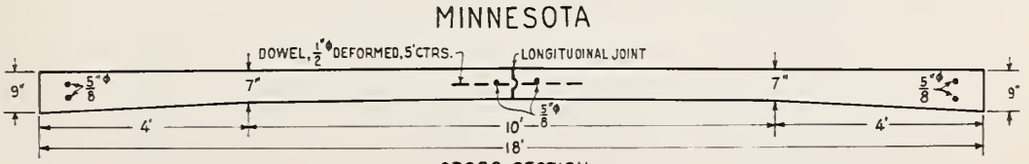
MINNESOTA



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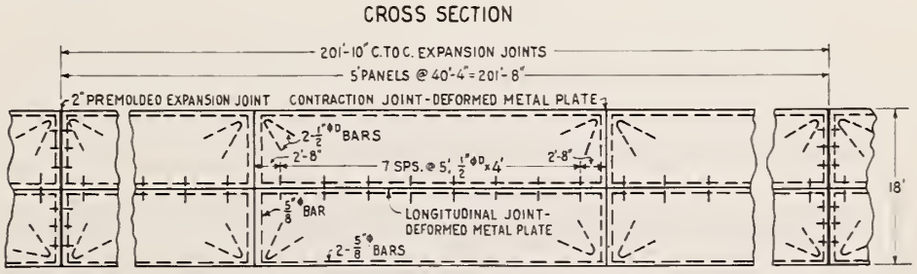
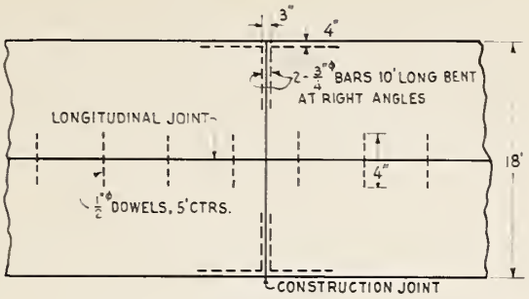


PLAN

SPECIAL FEATURES OF CONCRETE PAVEMENT DESIGNS FOR 1926

NEBRASKA



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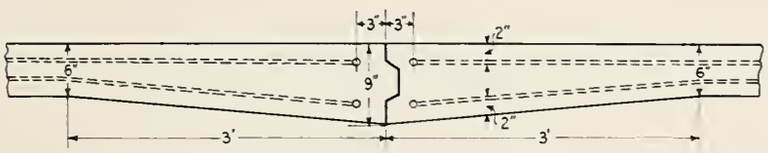
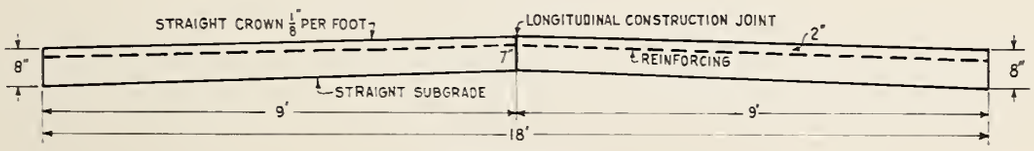


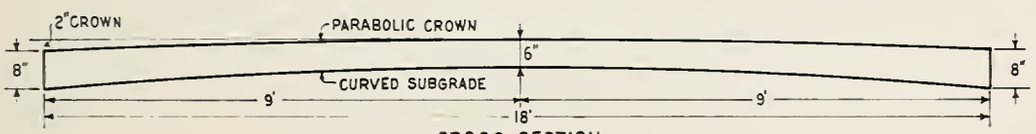
DETAIL OF CONSTRUCTION JOINT

NEW YORK



CROSS SECTION

NORTH CAROLINA



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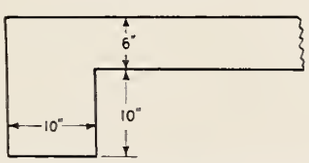
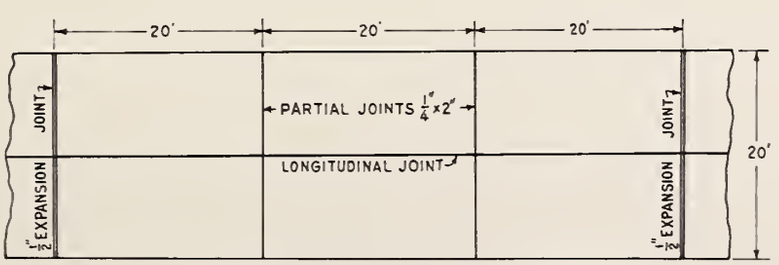
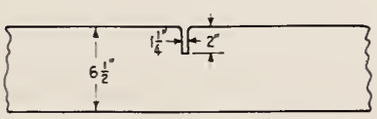


DETAIL AT BEGINNING AND ENDING OF PAVEMENT - LONGITUDINAL SECTION

WASHINGTON



PLAN OF PARTIAL JOINTS



SECTION OF PARTIAL JOINT

REDUCED IN THE PAST TEN YEARS. THE PUBLIC DEMAND FOR SMOOTH-RIDING ROADS AND BETTER APPRECIATION BY ENGINEERS OF THE IMPORTANCE OF IMPACT STRESSES HAS LED TO THE ADOPTION OF RIGID REQUIREMENTS IN FINISHING CONCRETE PAVEMENTS TO SECURE A HIGH DEGREE OF TRUE-NESS, AND THIS CARE IN FINISHING HAS PERMITTED A REDUCTION IN AMOUNT OF CROWN SO THAT IT IS NOW FEASIBLE TO CONSTRUCT 20-FOOT PAVEMENTS WITH ONLY ONE INCH OF CROWN.

THE GREATEST VARIATION BETWEEN DESIGNS APPEARS TO BE IN THE USE OF TRANSVERSE EXPANSION JOINTS, SOME STATES USING THEM AT 30-FOOT INTERVALS AND SOME STATES OMITTING THEM ENTIRELY. IT WILL BE NOTED THAT THIRTY-THREE STATES USE SOME KIND OF EXPANSION JOINT AND THAT THE MAJORITY OF THEM APPEAR TO FAVOR A SLAB LENGTH OF FROM 40 TO 60 FEET. FURTHER RESEARCH AND OBSERVATION OF PAVEMENTS ALREADY BUILT IS NECESSARY TO DETERMINE WHICH OF THE PRACTICES IS MORE NEARLY CORRECT.

DIFFERENCES IN LOCAL CONDITIONS NO DOUBT JUSTIFY CERTAIN DIFFERENCES IN DESIGN OF CONCRETE PAVEMENTS BUT IT IS BELIEVED THAT GENERAL AGREEMENT WILL EVENTUALLY BE REACHED IN MANY MAJOR FEATURES. MR. SURMAN OF ILLINOIS, IN HIS TALK AT PINEHURST, CRITICISED THE BUREAU FOR APPROVING ANY BUT THE THICKENED-EDGE DESIGN, BUT ENGINEERS FROM OTHER STATES CRITICISE US FOR APPROVING THE ILLINOIS DESIGN WHICH HAS NO EXPANSION JOINT. WE DO NOT BELIEVE THAT ANY ONE STATE HAS DEVELOPED THE ULTIMATE DESIGN FOR CONCRETE PAVEMENTS AND, SINCE IT IS NOT POSSIBLE TO REACH AN AGREE-MENT AS TO WHAT CONSTITUTES A CORRECT DESIGN, WE FEEL THAT IT WOULD BE UNWISE AND ARBITRARY FOR THE BUREAU TO INSIST AT THIS TIME THAT ALL STATES CONFORM TO A STANDARD DESIGN.

REPORT OF SUB-COMMITTEE ON DESIGN OF THE A.A.S.H.O.

The report of the Sub-committee on Design of the American Association of State Highway Officials, which was received at the Pinehurst, North Carolina, meeting of the Association on November 8, 1926, contains much interesting and instructive data. The sub-committee had at its disposal the information secured during the year from the several States in response to its questionnaires relative to guard rails, and amounts of widening on curves, superelevation, and crown for pavements. The sub-committee adopted the report and submitted it to the Committee on Standards of the Association, which will consider the report at the earliest convenient opportunity. The report was submitted by the chairman of the sub-committee, Mr. C. H. Moorefield, State Highway Engineer of South Carolina.

The report included the following recommendations:

Guard Rails

1. - That the wooden type of guard rail, if used, be limited in height so that the center of the top board shall not be above the center of the hub; and that wooden rails be not less than 3 inches by 10 inches in cross section.

2. - That cable guard rail consist of two 3/4-inch cables; the lower cable to be not less than 15 inches nor more than 18 inches above the ground, and the upper cable not less than 28 nor more than 33 inches above the ground.

3. - That the woven-wire type of guard rail when used be 2 feet in width and placed with the top approximately 36 inches above the ground.

4. - That guard-rail posts be spaced not exceeding 10 feet apart and preferably not exceeding 8 feet. That the minimum space from the inside edge of the rail to the edge of the shoulder of the road be 2 feet, and that the minimum distance from the same point on the rail to the center of the road be 12 feet.

Widening on Curves

1. - That the formula, proposed by J. T. Voshell of the Bureau, be followed in determining the additional width to be used on curves; and that all curves with a radius of 1,000 feet or less be widened.

FORMULA: $W = 2\left(R - \sqrt{R^2 - L^2}\right) + \frac{35}{\sqrt{R}}$

W = WIDENING IN FEET
R = RADIUS OF CURVE IN FEET
L = WHEEL BASE OF VEHICLES IN FEET (20 FEET RECOMMENDED)

$2\left(R - \sqrt{R^2 - L^2}\right)$ = ADDITIONAL WIDTH REQUIRED BY TWO CARS.

SUPERELEVATION

1. - THAT ALL CURVES WITH A RADIUS OF LESS THAN 6,000 FEET BE SUPERELEVATED.

2. - THAT MAXIMUM SUPERELEVATIONS APPROXIMATE 1 INCH PER FOOT OF WIDTH; AND THAT A VELOCITY OF 35 MILES PER HOUR BE USED IN THE FORMULA FOR DETERMINING THE SUPERELEVATION.

FORMULA: $E = .067 \frac{V^2}{R}$

E = SUPERELEVATION IN FEET PER FOOT OF WIDTH
V = VELOCITY IN MILES PER HOUR
R = RADIUS OF CURVE IN FEET

3. - THAT FULL SUPERELEVATION BE USED BETWEEN THE POINT OF CURVATURE AND THE POINT OF TANGENCY OF THE CURVE WITH SUITABLE EASEMENT DISTANCES.

GUARD RAIL

A MARKED CHANGE IN THE TYPE OF GUARD RAILS USED IN THE VARIOUS STATES HAS TAKEN PLACE DURING THE PAST FOUR YEARS. MANY OF THE STATES HAVE DROPPED THE WOODEN STYLE AND ADOPTED THE CABLE OR WOVEN WIRE. A NUMBER OF OTHER STATES ARE GIVING THE CABLE AND WOVEN-WIRE TYPES A TRIAL. PIPE RAILING WHICH WAS USED OCCASIONALLY IN 1922 HAS FALLEN COMPLETELY INTO DISUSE. A NEW COMBINATION CONSISTING OF A BOTTOM WOODEN RAIL AND A TOP CABLE IS NOW BEING USED TO SOME EXTENT BY OHIO AND NEW JERSEY.

THE DIMENSIONS OF THE GUARD RAILS AND THEIR LOCATION VARY CONSIDERABLY IN THE SEVERAL STATES. THE MINIMUM DISTANCE FROM THE EDGE OF THE PAVEMENT TO THE GUARD RAIL VARIES FROM 1 TO 9 FEET. THE AVERAGE DISTANCE IS NOW 43 INCHES. THE AVERAGE HEIGHT OF THE HIGH-TYPE-WOODEN GUARD RAIL IS 39 INCHES AT THE PRESENT TIME; OF THE LOW-TYPE-WOODEN GUARD RAIL, 23 INCHES; OF THE CABLE STYLE, $31\frac{1}{2}$ INCHES; AND OF THE WOVEN-WIRE DESIGN, 36 INCHES. THE CURB GUARD IN COMBINATION WITH GUARD RAIL IS USED BY A FEW STATES ON BRIDGES OR AT EXTREMELY HAZARDOUS POINTS.

Of the 46 States reporting in 1926, 3 reported serious accidents which were attributed to the high-type-wooden guard rail; 1 tabulated such an accident for the low-wooden rail style; while no accidents were marked against the cable and woven-wire designs.

A summary of the guard rail information is shown in Table 1. The detailed data for the individual States as shown in the report of the sub-committee are given in Table 2.

Widening on Curves

The methods and amount of widening on curves now used show a wide divergence in the several States, although practically every State widens pavements on curves to some extent. Table 3 gives the replies taken from the 1926 questionnaire.

It has been a difficult matter to condense the replies into a reasonable space and for this reason it has been found desirable to omit a number of interesting computations and graphs. Table 3 gives the amount of widening used on definite degrees of curvature. In a few States, however, the amount of widening varies with the size of the central angle as well as with the degree of curve. Most States widen their pavements on the inside of the curve, although some widen on the inside, outside, or both, depending upon local conditions.

It may be said in general that the average amount of widening has been increased since 1922. The decrease of the previous maximum has tended toward a greater uniformity in general practice. Figure 1 illustrates approximately the average amount of widening used by the States reporting in 1926. Curves are also shown which represent a few formulas which have been suggested for determining the proper amount of widening.

Superelevation on Curves

The amount of superelevation on curves depends upon several factors such as the radius of curvature, length of curve, length available for transition, width of pavement, speed of vehicles, grade of road, and type of surfacing. As in the matter of widening, there is a large variation in the practice of the various States.

TABLE 1. - SUMMARY OF GUARD-RAIL QUESTIONNAIRE FOR 1926

KIND OF GUARD RAIL	YEARS		
	1922	1924	1926
NUMBER OF STATES USING:			
1. - HIGH-TYPE-WOODEN GUARD RAIL			21
2. - LOW-TYPE-WOODEN GUARD RAIL			7
3. - WOODEN GUARD RAIL	45	31	28
4. - CABLE GUARD RAIL	3	17	29
5. - WIRE-MESH GUARD RAIL	0	8	23
6. - WOOD BOTTOM RAIL WITH CABLE TOP RAIL	0	1	2
7. - CURBS IN CONNECTION WITH GUARD RAILS (USED OCCASIONALLY)	5	3	2
NUMBER OF STATES REPORTING ACCIDENTS CAUSED BY:			
1. - HIGH-TYPE-WOODEN GUARD RAIL			9
2. - LOW-TYPE-WOODEN GUARD RAIL			1
3. - CABLE-TYPE GUARD RAIL			0
4. - WOVEN-WIRE-TYPE GUARD RAIL			0
AVERAGE HEIGHT OF GUARD RAILS REPORTED BY STATES:			
1. - HIGH-TYPE-WOODEN GUARD RAIL			33 IN.
2. - LOW-TYPE-WOODEN GUARD RAIL			23 IN.
3. - CABLE-TYPE GUARD RAIL			31⅓ IN.
4. - WOVEN-WIRE-TYPE GUARD RAIL			36 IN.
AVERAGE DISTANCE OF GUARD RAIL FROM EDGE OF PAVEMENT AS REPORTED BY STATES			43 IN.
NUMBER OF STATES REPORTING	47	39	46

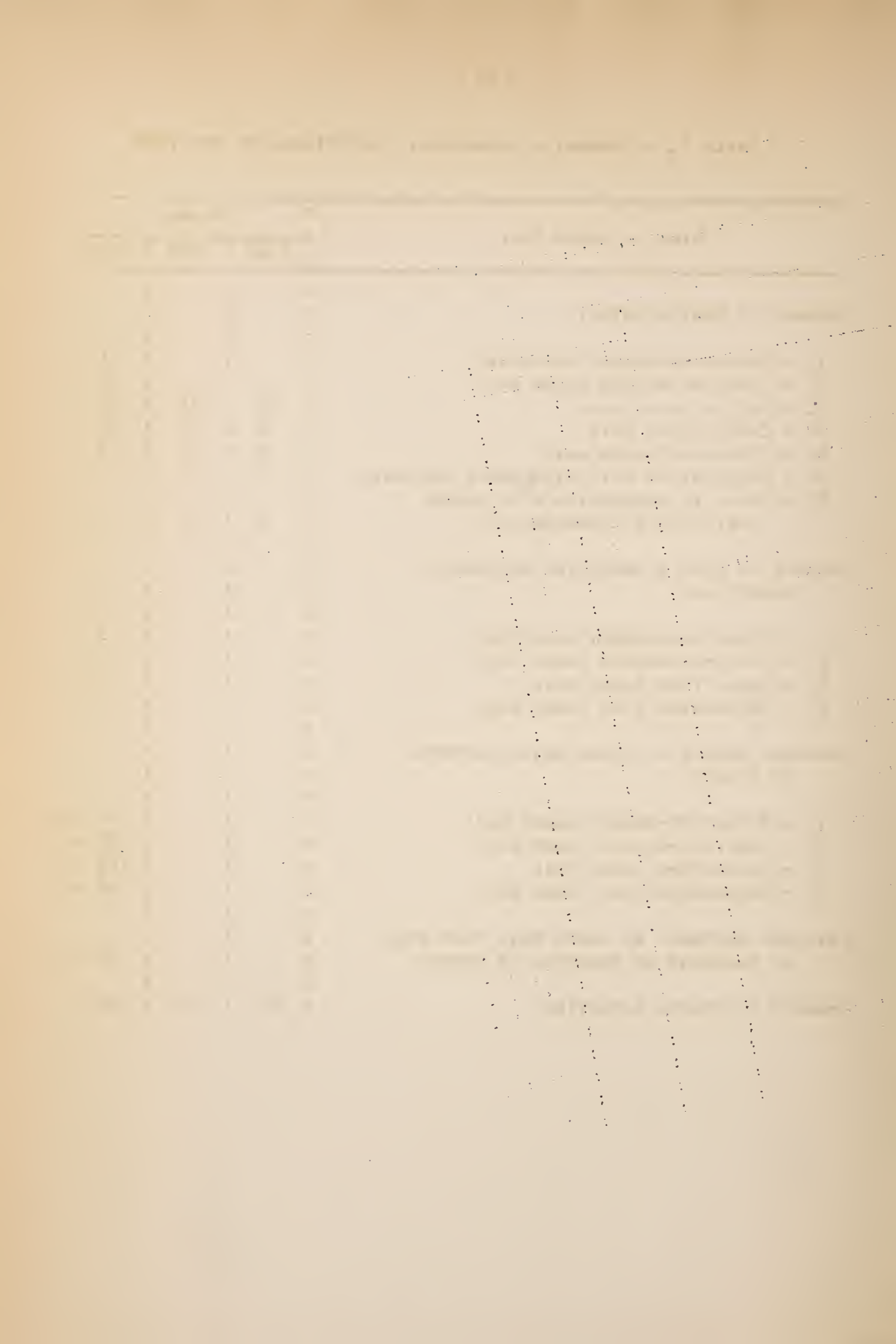


Table 2. - Detailed data compiled from the guard-rail questionnaire for 1926

State	Kind of guard rail								Distance to edge of pavement	Curbs Used		Serious injury attributed to guard rail		Remarks
	Wooden		Cable			Woven wire	Other kinds							
	Rails	Height	Cables	Size	Height	Height	Height			Yes	No	Yes	No	
	Number	Inches	Number	Inches	Inches	Inches	Inches		Inches					
Alabama	-	-	2	3/4	30	-	-		24	-	x	-	x	
Arizona	-	-	2	3/4	30	42	-		27	-	x	-	x	
Arkansas	2	42	2	3/4	39	-	-		36	-	x	-	x	
California	1	26	-	-	-	-	-		-	-	x	x	x	Rails set 1 foot inside of shoulder. One-rail type has not caused accidents; 2-rail (old type) has.
Colorado	-	-	2	3/4	30	36	-		48	-	x	-	x	
Connecticut	2	42	-	--	-	-	-		53	-	x	x	-	
Delaware	-	-	2	3/4	36	-	-		108	-	x	-	x	
Florida	2	40	-	-	-	36	-		36	-	x	-	x	
Georgia	1	27	2	3/4	30	36	-		40	-	x	-	x	
Idaho	1	34	-	-	-	36	-		-	-	x	-	x	Wooden guard rail, set 1 foot from shoulder, has pole top rail.
Illinois	-	-	-	-	-	-	-		-	-	-	-	-	1926 report not received.
Indiana	-	-	2	3/4	30	-	-		72	-	x	-	x	
Iowa	-	-	2	3/4	33	-	-		48	-	x	-	x	
Kansas	-	-	2	3/4	33	36	-		60	x	x	-	x	Curbs used on bridges 3'-6" inside guard rail but not on roadways.
Kentucky	-	-	2	3/4	30	-	-		36	-	x	-	x	1924 report.
Louisiana	2	36	-	-	-	36	-		36	-	x	-	x	
Maine	2	36	2	3/4	33	34	-		24	-	x	-	x	
Maryland	-	-	-	-	-	38	-		54	-	x	-	x	Woven wire is wire fencing material.
Massachusetts	2	42	-	-	-	-	-		36	-	x	-	x	
Michigan	-	-	2	3/4	27	-	-		72	-	x	-	x	
Minnesota	-	-	1	3/4	24	-	-		72	-	x	-	x	
Mississippi	-	-	-	-	-	36	-		24	-	x	-	x	
Missouri	2	42	2	3/4	30	-	-		48	-	x	-	-	1924 report. Details of cables and mesh may be incorrect.
Montana	1	22	-	-	-	-	-		-	-	x	-	x	Placed 1 foot from shoulder.
Nebraska	-	-	2	3/4	35	39	-		54	-	x	-	x	
Nevada	1	23	-	-	-	36	-		36	-	x	-	x	
New Hampshire	2	29	2	3/4	32	-	-		36	-	x	x	x	Wooden guard rail has caused accidents. Cable has not.
North Carolina	2	42	2	3/4	32	36	-		42	-	x	-	-	1924 report. Details of cables and woven wire may be incorrect.
North Dakota	-	-	1	3/4	18	-	-		36	-	x	-	x	
Ohio	2	34												Other kinds include a combination
	1	22	2	3/4	32	34	32		53	-	x	x	-	guard rail with bottom rail wood and top a cable.
Oklahoma	-	-	2	3/4	30	33	-		60	-	x	-	x	
Oregon	2	36	-	-	-	-	-		42	-	x	-	x	
Pennsylvania	-	-	2	3/4	36	-	-		42	-	x	-	x	In dangerous places top cable is 1-inch diameter.
Rhode Island	2	36	-	-	-	-	-		42	-	x	-	-	
South Carolina	2	26	-	-	32	-	-		24	x	-	x	x	High-type-wooden guard rail has caused accidents. Curbs used on bridges.
South Dakota	-	-	2	3/4	32	36	-		36	-	x	x	x	Old-wooden-guard-rail type caused accidents. Not used now.
Tennessee	2	42	2	3/4	36	36	-		42	-	x	-	x	
Texas	2	42	2	3/4	36	33	-		24	-	-	x	x	Wooden, yes. Woven wire, no.
Utah	-	-	-	-	-	-	-		-	-	-	-	-	No report.
Vermont	2	42	2	3/4	32	-	-		22	-	x	-	x	
Virginia	2	44	2	3/4	36	38	-		36	-	x	-	x	
Washington	2	35	-	-	-	-	-		12	-	-	-	-	
West Virginia	-	-	2	3/4	30	36	-		54	-	x	-	x	Height of woven wire may be incorrect.
Wisconsin	1	18	2	3/4	32	-	-		12	-	x	x	x	Wooden, yes. Cable, no.
Wyoming	2	39	-	-	-	36	-		27	-	x	x	x	Wooden, yes. Woven wire, no.

Table 3. - Detailed data compiled from the curve-widening questionnaire for 1926

State	Additional width required at middle ordinate of curve: D-5° R-1146 ft	D-10° R-573 ft	D-15° R-382 ft	D-20° R-287 ft	D-30° R-191 ft	D-40° R-143 ft	Amount at point of curvature	Distance from P.C. to point of zero widening	Location of widening	Remarks
	Feet	Feet	Feet	Feet	Feet	Feet	Per cent	Feet		
Alabama	0	2.00	2.00	2.50	3.00	-	100	100	Inside	
Arizona	1.0	2.00	2.50	2.75	3.00	3.50	100	100	do	
Arkansas	-	2.00	4.00	5.00	6.00	6.00	50	-	do	Spiral
California	-	-	-	-	-	-	-	-	-	None
Colorado	-	-	3.00	3.25	3.50	4.00	-	-	Inside	Approximate
Connecticut	-	-	-	-	-	-	-	-	-	Variable
Delaware	-	2.00	4.00	5.00	6.00	6.00	50	-	Inside	Spiral
Florida	-	-	-	-	-	-	-	-	-	Do not widen
Georgia	0	2.50	2.50	3.00	3.50	4.00	100	100	Inside	Table
Idaho	-	2.00	3.00	3.50	4.00	4.00	None	0	Inside or outside	Full widening in 150 feet
Illinois	-	-	-	-	-	-	-	-	-	No report
Indiana	-	2.00	2.50	4.00	5.00	5.00	50	60	Inside	Table
Iowa	-	1.00	1.25	2.00	3.5	5.00	Variable	Variable	Inside	Extra width for delta = 40° = .0036D - .0225
Kansas	-	2.00	4.00	7.00	7.00	7.00	100	50 to 100	-	See table
Kentucky	-	-	-	-	-	-	-	-	-	No report
Louisiana	2.4	4.4	6.0	6.0	6.0	6.0	50	60 to 180	Inside	See table
Maine	-	-	-	-	-	-	-	-	-	No widening
Maryland	3.00	3.00	3.00	3.00	3.00	4.00	-	-	-	See table
Massachusetts	-	3.00	5.00	5.00	5.00	5.00	60 and 80	40 to 120	Inside	do
Michigan	2.00	2.50	2.75	3.00	3.00	3.00	35	60 to 80	do	B.P.R. method. See table. Spiral
Minnesota	2.00	2.30	3.00	3.70	5.00	5.00	50	100	do	See table
Mississippi	0	2.50	3.00	3.00	3.50	4.00	100	100	do	do
Missouri	-	-	-	-	-	-	-	-	-	No report
Montana	0	2.00	2.50	3.00	3.50	4.00	100	70 to 200	Inside	Variable with curve length
Nebraska	2.00	4.00	6.00	7.00	8.00	9.00	100	100 to 200	do	Variable. See table
Nevada	1.00	1.50	2.00	2.50	3.00	3.00	-	-	do	Variable with delta. Use simple curve
New Hampshire	-	2.50	2.50	2.50	3.00	3.50	100	100	do	See table
New Jersey	0	3.00	3.00	3.00	3.00	3.00	50	50	do	3 feet for curves over 7°
New Mexico	-	-	-	-	-	-	-	-	-	No report
New York	-	4.00	5.00	6.00	6.00	6.00	-	-	Inside	See table
North Carolina	-	-	-	-	-	-	-	-	-	No report
North Dakota	-	-	-	-	-	-	-	-	-	Do not widen
Ohio	0	1.25	2.50	3.75	6.25	8.00	67	100	Inside	See table
Oklahoma	0	2.5	5.00	7.50	12.00	12.00	50	-	do	0.5 ft. per degree of curve over 5°
Oregon	0	2.00	2.00	3.00	4.00	4.00	-	-	-	-
Pennsylvania	-	2.00	4.00	5.00	6.00	6.00	50	-	Inside	Spiral
Rhode Island	-	-	-	-	-	-	-	-	-	No report
South Carolina	-	-	-	-	-	-	-	-	-	None
South Dakota	1.5	2.20	3.00	3.70	5.10	-	50	50	Inside	See table
Tennessee	-	2.50	2.50	3.00	4.00	5.00	90±	50 to 80	do	do
Texas	-	2.30	3.00	3.70	5.00	5.00	50	50	do	do
Utah	-	-	-	-	-	-	-	-	-	No report
Vermont	0	2.00	2.00	2.00	2.00	2.00	100	100	Inside	All 2 feet extra
Virginia	-	-	-	-	-	-	-	-	-	No report
Washington	1.50	2.20	2.50	2.70	3.10	3.40	25	50	Inside	$W = \frac{3}{4} D$
West Virginia	-	-	2.00	2.00	3.00	4.00	100	50 to 100	do	See table
Wisconsin	-	2.00	4.00	5.00	6.00	6.00	50	40 to 60	do	do
Wyoming	-	-	-	-	-	-	-	-	-	Not shown
Average	1.82	2.3	3.2	3.9	4.8	5.0	68	80	27 inside; 1 inside or outside; 5 not shown	5 States do not widen
Number of States reporting	9	32	33	33	33	31	27	23	38	

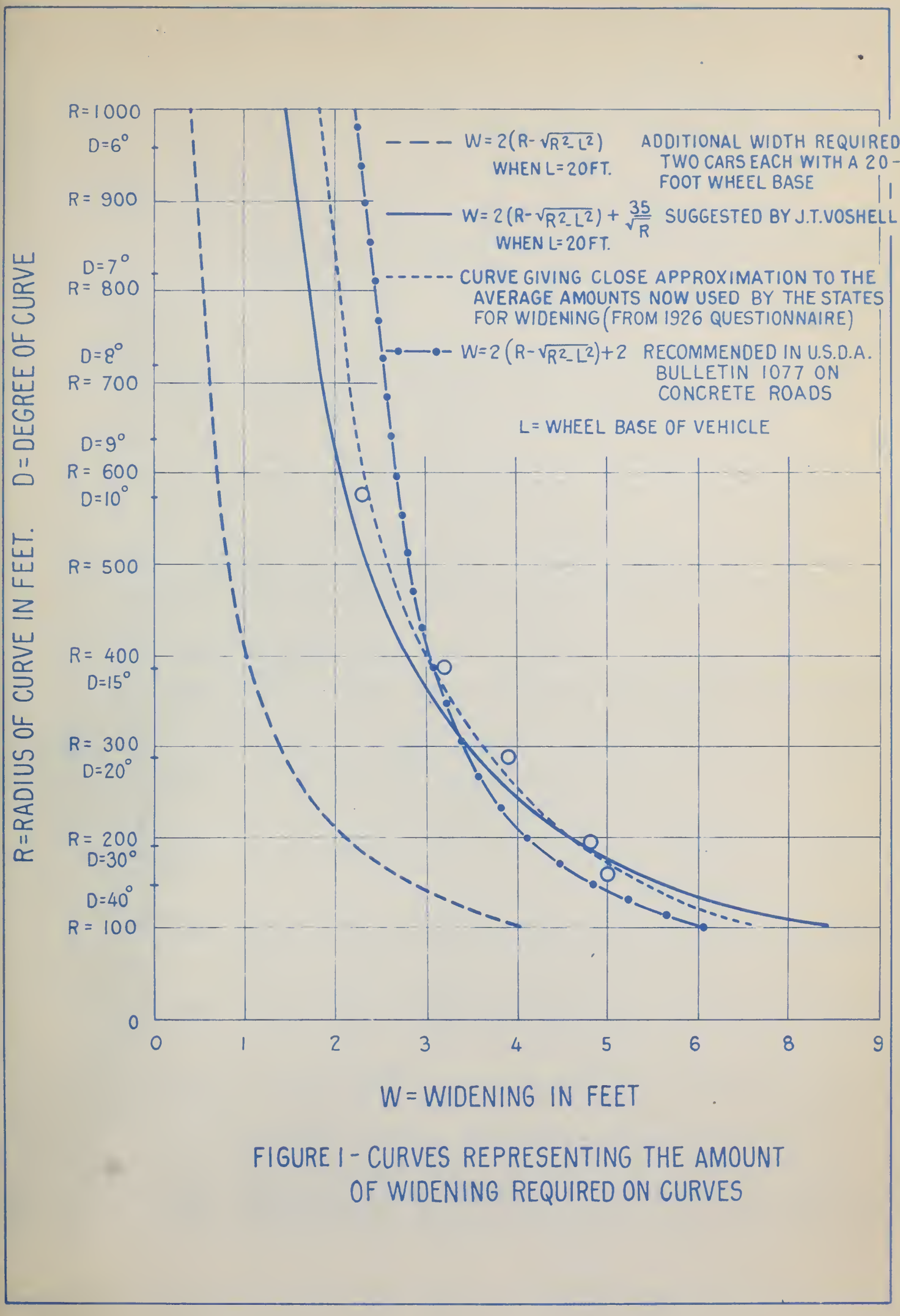


FIGURE 1 - CURVES REPRESENTING THE AMOUNT OF WIDENING REQUIRED ON CURVES

Table 4. - Detailed data compiled from the curve-superelevation questionnaire for 1926

State	Superelevation at middle ordinate of curve						Amount of superelevation at point of curvature	Transition distance	Fixed base line on pavement	Minimum curvature superelevated	Remarks
	D = 5° R = 1146 ft.	D = 10° R = 573 ft.	D = 15° R = 382 ft.	D = 20° R = 287 ft.	D = 30° R = 191 ft.	D = 40° R = 143 ft.					
	Inches	Inches	Inches	Inches	Inches	Inches	Per cent	Feet		Degrees	
Alabama	0.625	1.00	1.00	1.00	1.00	1.00	100	150	Inside edge	1	
Arizona	0.62	1.07	1.28	1.41	1.50	1.50	67	100	-	1	
Arkansas	0.50	0.75	0.75	1.00	1.00	1.00	50	50	Inside edge	6	
California	0.36	0.84	1.08	1.40	1.50	1.50	100	100	Center line	3	$S = \frac{1}{R}(50 - \frac{600}{delta})$
Colorado	-	-	-	-	-	-	-	-	-	-	20 miles per hour
Connecticut	-	-	-	-	-	-	-	-	-	-	Variable
Delaware	0.50	0.75	0.75	1.00	1.00	1.00	50	50+	Inside edge	2 1/2	Begins at point of spiral
Florida	-	-	-	-	-	-	-	-	-	-	Usesbureau standard
Georgia	0.48	0.84	0.96	0.96	0.96	0.96	100	100	Center line	1	Table
Idaho	0.624	1.20	1.24	1.20	1.20	1.20	50	60	do	1	do
Illinois	-	-	-	-	-	-	-	-	-	-	No report
Indiana	0.24	0.48	0.72	0.78	0.78	0.78	67	60	Center line	2	Table
Iowa	0.50	0.50	0.75	0.75	0.75	0.75	100	80 to 125	do	3	
Kansas	0.50	0.50	0.75	1.00	1.00	1.00	100	50 to 150	-	5	Table
Kentucky	-	-	-	-	-	-	-	-	-	-	No report
Louisiana	0.30	0.58	0.80	0.80	0.80	0.80	50	60 to 160	-	-	
Maine	0.627	1.00	1.00	1.00	1.00	1.00	-	-	-	-	$S = \frac{0.8\ V^2}{R}$ inches
Maryland	0.375	0.50	0.75	0.75	0.75	0.75	-	-	-	-	Table
Massachusetts	0.36	0.82	1.00	1.00	1.00	1.00	96	50 to 200	Inside edge	3	Table
Michigan	0.44	0.60	1.00	1.00	1.00	1.00	50	50 to 80	do	1	do
Minnesota	0.53	0.75	0.75	0.75	0.75	0.75	80	50 to 200	Center line	2	do
Mississippi	0.50	0.875	1.00	1.00	1.00	1.00	100		Inside edge	1	Table
Missouri	-	-	-	-	-	-	-	-	-	-	No report
Montana	-	0.50	0.50	0.75	0.75	1.00	100	75 to 300	Center line	9	Variable with length of curve
Nebraska	0.50	0.75	0.75	0.75	0.75	0.75	93	100 to 300	1	2	Table
Nevada	0.50	0.63	0.71	0.76	0.90	1.00	-	-	Inside edge	5	do
New Hampshire	0.45	0.89	1.00	1.00	1.00	1.00	100	50	Center line	3	do
New Jersey	0.33	0.58	0.68	0.68	0.68	0.68	50	50	1	5	do
New Mexico	-	-	-	-	-	-	-	-	-	-	Table not received
New York	0.75	1.25	1.37	1.50	1.50	1.50	-	-	Center line	3 1/2	Table
North Carolina	-	-	-	-	-	-	-	-	-	-	No report
North Dakota	0.67	0.67	1.00	1.00	1.00	1.00	100	100	-	-	
Ohio	0.65	0.81	0.90	0.98	1.25	1.25	67	100	Center line	1	Table
Oklahoma	0.45	0.66	1.00	1.20	1.20	1.20	50	-	do	4	$S = \frac{701.9547}{R}$
Oregon	0.72	1.02	1.20	1.32	1.44	1.57	-	-	-	1	$S = \frac{.067\ V^2}{R}$
Pennsylvania	0.50	0.75	0.75	1.00	1.00	1.00	50	50	-	-	Begins at point of spiral
Rhode Island	-	-	-	-	-	-		150	-	4	No details
South Carolina	0.625	0.875	0.875	0.875	0.875	0.875	100	-	-	1	Transition distance 1 foot per 1 inch of superelevation
South Dakota	0.51	0.82	0.84	0.86	0.91	0.91	50	50	-	-	Table
Tennessee	0.375	0.675	1.00	1.00	1.00	1.00	100	100 to 150	Center line	1	do
Texas	-	0.75	1.00	1.00	1.25	1.38	50	50	do	8	do
Utah	-	-	-	-	-	-	-	-	-	-	No report
Vermont	0.56	0.67	0.78	0.78	.78	0.78	100	100	-	4	
Virginia	-	-	-	-	-	-	-	-	-	-	No report
Washington	0.72	0.94	0.96	1.08	1.20	1.20	68	75	Center line	2	Table
West Virginia	0.50	0.87	1.00	1.125	1.125	1.125	100	50 to 100	do	3 1/2	do
Wisconsin	0.50	0.75	0.75	0.75	0.75	0.75	100	150	do	1	do
Wyoming	0.63	1.00	1.00	1.00	1.00	1.00	100	60	do	1	do
Average	0.513	0.791	0.915	0.98	1.01	1.02	79	94			
Number of States reporting	35	37	37	37	37	37	32	31			

Table 4 gives the answers to the 1926 questionnaire as tabulated by the Sub-committee. Superelevation is now used on 1-degree curves by at least 9 States. Many States, however, do not superelevate curves with a radius of more than 1,500 feet. The average maximum superelevation is 1.02 inches per foot of width, although there are several States using a maximum of 1.5 inches per foot of width. Due to the wide variations in the prevailing formulas, it was found most convenient to tabulate the superelevation for definite degrees of curvature. A brief summary of the table shows the average superelevation for a 5-degree curve to be 0.513 inch per foot of width; for a 10-degree curve, 0.791 inch; for a 15-degree curve, 0.915 inch; for a 20-degree curve, 0.98 inch; for a 30-degree curve, 1.01 inches; and for a 40-degree curve, 1.02 inches. The superelevation begins at an average distance of 94 feet from the point of curvature and reaches an average of 73 per cent of the full value at the point of curvature. There is a great difference in the methods of transition. Many States use the full superelevation at the point of curvature and point of tangency with an easement of 100 to 150 feet. Other States use only 50 per cent of the full superelevation at the point of curvature with an easement distance extending from 50 to 75 feet both ways from this point.

Compensation of Grades for Curvature

Only 8 States reported any compensation for grades on curves. In most cases the amount of compensation, where used, is determined by the length and radius of the curve and such local restrictions as sight, distance and cost. Table 5 shows the results of the 1926 questionnaire as averaged by the sub-committee.

California compensates for all grades of 6 per cent or more. Tennessee makes a reduction in grade of 1 per cent for each 50-foot reduction in radius below 200 feet. Oregon limits the grade to 4 per cent on curves of over 28 degrees.

Pavement Crowns

The crowns for all types of hard-surface roads are about the same for a given width according to the answers received from the 1926 questionnaire as briefed in Table 5. A few States still use a greater crown for bituminous roads than for the cement concrete type.

Table 5. - Detailed data compiled from the 1926 questionnaire relative to compensation of grades for curvature and the amount of crown for paved roads

State	Compensation of grades for curvature			Amount of crown for paved roads					
	Yes	No	Remarks	18 feet	20 feet	24 feet	Other widths		Remarks
							Width	Crown	
				Inches	Inches	Inches	Feet	Inches	
Alabama	-	x		2.00	2.25	2.75	-	-	
Arizona	-	x		1.125	1.25	1.50	-	-	
Arkansas	-	x		1.50	-	-	-	-	
California	x	-	On grades over 6 per cent	-	1.00	1.25	30	1.5	
Colorado	x	-	Variable	1.50	-	-	-	-	
Connecticut	-	x		2.25	2.50	3.00	-	-	
Delaware	-	x		2.00	2.00	2.00	-	-	
Florida	-	x		2.25	3.00	4.375	-	-	
Georgia	-	x		1.50	1.75	2.00	-	-	
Idaho	-	x		1.50	-	-	-	-	
Illinois	-	-		-	-	-	-	-	
Indiana	-	x		2.00	2.00	-	-	-	
Iowa	-	x		2.00	2.00	-	-	-	
Kansas	-	x		2.00	-	-	-	-	
Kentucky	-	-		2.25	2.50	3.00	-	-	
Louisiana	-	x		2.00	2.50	3.00	-	-	
Maine	-	x		1.25	1.50	-	-	-	
Maryland	-	x		2.00	2.00	-	-	-	
Massachusetts	-	-		2.25	2.50	3.00	-	-	
Michigan	-	x		1.75	2.00	3.00	-	-	
Minnesota	-	x		1.00	1.00	1.50	27	3.00	
Mississippi	-	x		2.00	-	-	-	-	
Missouri	-	-		1.50	-	-	-	-	
Montana	-	-		2.00	-	-	-	-	
Nebraska	-	x		1.50	1.75	2.25	-	-	
Nevada	-	x		1.25	-	-	-	-	
New Hampshire	-	x		2.25	2.50	3.00	-	-	
New Jersey	-	x		-	1.50	-	-	-	A straight line curb to center
New Mexico	-	x		-	-	-	-	-	
New York	-	x		1.125	1.25	-	-	-	
North Carolina	-	-		2.00	-	-	-	-	
North Dakota	-	x		1.0	1.125	-	-	-	
Ohio	-	x		1.75	2.00	-	-	-	
Oklahoma	x	-		2.00	-	-	-	-	
Oregon	x	-	Limits grade to 4 per cent on curves over 28 degrees	1.50	1.50	-	-	-	
Pennsylvania	-	x		2.00	2.50	3.0	-	-	
Rhode Island	-	x		2.0	-	-	-	-	
South Carolina	-	x		2.00	2.00	-	-	-	
South Dakota	-	-		1.12	1.25	1.50	-	-	
Tennessee	x	-	Limits grade 1 per cent for each 50 foot radius below 300 feet	1.33	1.667	2.0	-	-	Concrete
			Limits grade 1 per cent for each 50 foot radius below 300 feet	2.25	2.50	3.00	-	-	Bituminous
Texas	-	x		2.25	2.50	3.00	-	-	Concrete
				3.37	3.75	4.50	-	-	Bituminous
Utah	-	-		-	-	-	-	-	
Vermont	-			2.00	-	-	-	-	
Virginia	x	-	Variable	2.25	2.50	3.00	-	-	
Washington	-	-	Limits grades over 5 per cent	1.50	1.50	2.00	-	-	
West Virginia	x	-	Limits grades	2.25	-	-	-	-	
Wisconsin	-	x		1.00	1.25	1.50	-	-	
Wyoming	-			-	-	-	-	-	
Average	8	33		1.750	1.89	2.482	-	-	
Number of States reporting	41			45	33	25			

A COMPARISON OF THE 1926 TABULATION WITH THOSE MADE IN 1922 AND 1924 SHOWS A SLIGHT TENDENCY TO REDUCE THE HEIGHT OF CROWN. IN 1922 THE AVERAGE CROWN OF AN 18-FOOT CONCRETE ROAD WAS 1.88 INCHES; IN 1924, 1.77 INCHES; AND IN 1926, 1.753 INCHES. THE AVERAGE CROWN OF A 20-FOOT PAVEMENT IN 1926 IS 1.89 INCHES, AND THAT OF A 24-FOOT PAVEMENT IS 2.482 INCHES.

PROGRESS OF FEDERAL HIGHWAY LEGISLATION

H. R. 14254 - Introduced in the House on December 7, 1926, by C. C. Dowell of Iowa, and referred to the Committee on Roads.

Provides for an amendment to existing Federal-aid road legislation preventing the use of the United States shield for any purpose other than as a marker for United States highways.

H. R. 14565 - Introduced in the House on December 8, 1926, by Scott Leavitt of Montana and referred to the Committee on Roads.

Provides that the wording of the Federal Highway act of 1921 be revised so as to read that "Before any projects are approved in any State, such State through its State highway department, shall select or designate a system of highways not to exceed 7 per centum of the total highway mileage of such State as shown by the records of the State highway department on December 31, 1926."

H. R. 14828 - Introduced in the House on December 10, 1926, by S. S. Arentz of Nevada, and referred to the Committee on Roads.

First, provides for an amendment to existing Federal-aid road legislation preventing the use of the United States shield for any purpose other than as a marker for United States highways.

Second, provides that the paragraph of the Federal highway act of 1921 be repealed, which prohibits the use of more than 60 per cent of the Federal aid allotted to any State on the primary or interstate highways until provision has been made for the improvement of the entire system.

H. R. 1429 - Introduced in the House on December 11, 1926, by W. F. Stevenson of South Carolina and referred to the Committee on Roads.

Provides that 20 per cent of the Federal-aid road funds allotted to South Carolina be used for the repair and maintenance of post roads which are not main or interstate highways.

H. R. 15008 - The agricultural appropriation bill. Introduced in the House on December 13, 1926, by W. W. Magee of New York.

Provides for an appropriation for forest roads and trails of $6,500,000. Of this amount $275,000 is a part of the authorization for the fiscal year 1928, and the balance is from the authorization for the fiscal year 1927.

Provides for an appropriation for Federal-aid roads of $71,000,000. Of this amount $23,800,000 is the remainder of the $75,000,000 authorized for the fiscal year ending June 30, 1926 and the balance is from the authorization for the fiscal year 1927.

S. 4602 - Introduced in the Senate on December 7, 1926, by T. L. Oddie of Nevada and referred to the Committee on Post Offices and Post Roads.

Contains provisions identical with those in H. R. 14828.

S. 4675 - Introduced in the Senate on December 9, 1926, by C. du Pont of Delaware and referred to the Committee on Post Offices and Post Roads.

Provides for the construction of a post road and military highway from a point on or near the Atlantic coast to a point on or near the Pacific coast.

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF PUBLIC ROADS

STATUS OF CURRENT FEDERAL AID ROAD WORK

FOR THE FISCAL YEAR ENDING JUNE 30, 1927

AS OF NOVEMBER 30, 1926

STATES	BALANCE OF FEDERAL AID FUND AVAILABLE FOR NEW PROJECTS	* UNDER CONSTRUCTION			APPROVED FOR CONSTRUCTION			AMOUNT PAID STATES DURING FISCAL YEAR	COMPLETED AND PAID DURING FISCAL YEAR			AGREEMENTS NOW IN FORCE			P.S.& E. RECOMMENDED FOR APPROVAL BY DISTRICT ENGINEER			STATES
		FEDERAL AID	MILES ORIGINAL	MILES STAGE	FEDERAL AID	MILES ORIGINAL	MILES STAGE		FEDERAL AID	MILES ORIGINAL	MILES STAGE	FEDERAL AID	MILES ORIGINAL	MILES STAGE	FEDERAL AID	MILES ORIGINAL	MILES STAGE	
ALABAMA	$ 2,168,260.31	$ 2,744,634.98	270.0	4.8	$ 70,908.93	13.4		$ 445,280.28	$ 639,665.69	100.5		$ 2,375,027.26	217.6	4.8	$ 440,516.65	55.9		ALABAMA
ARIZONA	2,483,925.76	1,097,546.15	85.0					148,399.74	172,004.74	26.7		995,598.25	80.7		101,947.90	4.3		ARIZONA
ARKANSAS	753,831.78	1,991,172.27	272.9		741,335.08	94.3		567,248.30	452,766.52	74.3		2,009,241.54	282.6		723,265.81	94.6		ARKANSAS
CALIFORNIA	2,337,900.12	5,131,922.51	245.2	17.7	127,564.21	7.1		1,425,777.92	1,471,835.86	105.7		4,916,907.68	235.8	17.7	342,579.04	16.7		CALIFORNIA
COLORADO	1,700,625.19	2,716,073.46	258.8	9.2	299,416.03	30.2		607,654.14	482,409.14	32.7		2,221,423.90	205.9	9.2	794,055.69	93.1		COLORADO
CONNECTICUT	406,879.07	1,585,525.34	73.0		86,791.17	3.1		26,848.97	153,899.62	8.0		1,279,760.55	63.1		392,555.96	13.0		CONNECTICUT
DELAWARE	12,427.21	373,034.05	25.4					171,518.48	306,931.14	17.6		301,328.50	17.9		71,705.55	7.5		DELAWARE
FLORIDA	1,163,709.39	4,028,953.64	227.3	24.8	28,095.00	1.9		694,471.40	1,049,833.65	62.6		3,785,525.05	227.3	11.8	271,523.59	1.9	13.0	FLORIDA
GEORGIA	37,169.77	5,531,487.59	496.3	130.1	15,848.05	7.6		1,163,832.37	1,183,209.73	165.5		5,238,974.81	497.6	108.0	308,360.83	6.3	22.1	GEORGIA
IDAHO	212,161.92	1,473,377.82	173.0	15.5	272,439.27	39.3	0.2	733,415.04	719,535.29	62.2	12.9	1,244,929.81	143.0	6.4	500,887.28	69.3	9.3	IDAHO
ILLINOIS	3,158,885.91	4,639,573.48	345.7		432,782.21	32.6		211,371.43	980,960.66	68.1	2.0	4,095,262.94	301.5		977,092.75	76.8		ILLINOIS
INDIANA	672,759.63	8,223,878.57	502.5	11.6				1,508,857.18	1,135,591.61	71.0		7,860,170.94	480.0	11.6	363,707.63	22.5		INDIANA
IOWA	270,728.26	5,373,707.20	632.6	188.0	547,338.35	74.7	60.7	1,938,315.62	1,367,487.09	200.7	34.8	5,732,347.71	671.4	244.0	188,697.94	35.9	4.7	IOWA
KANSAS	218,817.71	5,580,237.15	781.8	4.1	838,968.54	113.0	4.5	965,188.86	235,898.35	48.9		5,315,796.75	747.9	4.9	1,103,408.94	146.7	3.7	KANSAS
KENTUCKY	180,604.68	3,586,433.98	383.2	48.7	656,264.63	62.6		584,332.72	297,523.46	13.3	14.6	3,543,989.30	378.6	48.7	699,709.31	67.2		KENTUCKY
LOUISIANA	364,715.03	1,734,604.66	185.1		640,869.93	42.1		524,251.89	387,478.39	31.9		1,967,231.03	179.0		408,243.56	48.2		LOUISIANA
MAINE	728,839.37	912,095.53	70.7		402,821.22	33.2		448,360.03	228,564.49	19.1		1,314,916.75	103.9					MAINE
MARYLAND	10,371.18	716,072.29	73.8					221,265.09	85,622.31	14.8		696,812.29	72.3		19,260.00	1.3		MARYLAND
MASSACHUSETTS	1,777,160.71	1,319,576.75	68.5		232,778.17	14.2		74,025.25	121,949.75	5.1		1,495,089.42	80.2		57,266.80	2.5		MASSACHUSETTS
MICHIGAN	1,494,839.54	6,557,259.62	413.2	34.9	274,496.50	15.6	3.5	1,709,825.05	188,717.04	13.6		6,318,983.62	398.5	34.9	512,772.50	30.3	3.5	MICHIGAN
MINNESOTA	41,634.33	1,823,600.00	270.5	68.8	41,000.00	108.6	42.1	2,220,925.30	2,099,429.11	365.2	92.1	1,785,600.00	249.4	68.8	79,000.00	130.7	42.1	MINNESOTA
MISSISSIPPI	292,667.25	3,698,750.24	377.7		158,917.61	34.9		686,464.41	563,148.80	71.7		3,379,962.95	338.9		477,704.90	73.7		MISSISSIPPI
MISSOURI	167,724.84	6,060,545.97	408.6	41.1	143,422.14	5.0	11.9	2,102,561.65	2,678,728.20	188.6	6.0	5,735,877.79	393.3	45.7	468,090.32	20.3	7.3	MISSOURI
MONTANA	4,420,172.67	1,732,168.83	172.2	8.2	429,967.89	87.3		607,192.31	509,109.72	59.1	37.5	2,103,313.99	250.5	8.2	59,822.73	9.0		MONTANA
NEBRASKA	1,601,551.88	6,486,758.49	1392.0	694.7	248,964.84	55.5	24.5	1,331,325.80	823,757.27	183.0	61.0	6,394,288.48	1398.7	709.3	341,434.85	58.8	9.9	NEBRASKA
NEVADA	324,494.86	1,764,770.48	239.9	32.4				417,963.91	1,575,015.07	183.2	5.1	1,537,107.36	223.1	32.2	227,663.12	16.8	0.2	NEVADA
NEW HAMPSHIRE	86,795.87	705,246.06	45.0					66,112.13				690,490.37	43.8		14,755.69	1.2		NEW HAMPSHIRE
NEW JERSEY	110,163.94	2,726,328.56	47.2		223,605.00	14.9		257,411.15	308,990.29	18.1		2,907,168.56	59.2		42,765.00	2.9		NEW JERSEY
NEW MEXICO	1,444,107.81	1,994,922.87	249.9		185,582.18	9.9		15,575.40	8,115.76	0.1		1,893,110.90	223.1		287,394.15	36.7		NEW MEXICO
NEW YORK	3,524,763.14	9,808,282.70	620.8		1,865,647.50	103.3	8.6	2,287,286.53	934,544.47	58.1		11,347,137.70	712.9		326,792.50	11.2	8.6	NEW YORK
NORTH CAROLINA	1,294.58	2,206,892.72	143.6		408,442.59	34.4		1,213,863.70	1,923,239.17	102.8	37.5	1,944,242.97	122.4		671,092.34	55.6		NORTH CAROLINA
NORTH DAKOTA	140,395.29	3,438,174.18	938.4	167.5	256,941.82	79.1	74.9	1,567,320.82	881,287.93	222.4	246.9	3,404,661.32	918.0	204.7	290,454.69	99.5	37.7	NORTH DAKOTA
OHIO	1,762,465.31	4,972,202.19	381.4	17.8	561,020.00	17.9		1,604,962.24	1,064,321.47	94.1		4,844,581.34	367.1	17.6	689,640.85	32.2		OHIO
OKLAHOMA	399,708.88	1,104,032.58	102.0	10.0	966,990.24	146.5	26.8	587,060.69	439,056.35	41.7	4.1	1,618,510.45	210.3	15.6	442,512.37	39.2	21.2	OKLAHOMA
OREGON	101,734.43	1,774,756.86	128.0	16.6	6,000.00	7.0	12.3	519,057.93	403,640.92	23.7		1,691,456.28	114.8	16.6	89,300.58	20.2	12.3	OREGON
PENNSYLVANIA	286,788.42	8,526,177.50	597.2		917,194.42	59.0		1,121,338.92	47,888.62	3.2		9,599,688.90	605.1		954,683.02	51.1		PENNSYLVANIA
RHODE ISLAND	418,934.94	326,130.00	21.8		250,155.00	16.6		333,747.28	113,520.00	7.6		514,275.00	34.3		62,010.00	4.1		RHODE ISLAND
SOUTH CAROLINA	46,792.86	2,491,292.35	194.5	14.7	42,921.68	10.3		611,379.41	454,194.28	58.0	6.9	2,409,292.35	185.2	14.7	124,921.58	19.6		SOUTH CAROLINA
SOUTH DAKOTA	136,954.15	1,878,341.39	643.0	78.6	30,539.05	13.0	32.6	783,624.97	517,228.44	177.9	75.8	1,835,603.37	639.5	78.6	73,277.07	16.5	32.6	SOUTH DAKOTA
TENNESSEE	298,914.83	3,817,387.29	236.0	58.0	320,518.04	35.0		1,256,445.35	567,186.82	44.4		3,687,088.35	223.8	58.0	450,816.98	47.2		TENNESSEE
TEXAS	2,049,047.28	7,572,699.59	721.1	128.6	1,884,190.93	126.9	116.3	2,076,409.14	1,660,238.48	247.3	16.4	7,971,441.59	725.4	168.1	1,485,448.93	122.6	76.8	TEXAS
UTAH	569,978.80	1,364,767.12	166.0		502,111.44	44.9		299,163.86	293,480.96	29.4		1,364,767.12	166.0		502,111.44	44.9		UTAH
VERMONT	352,224.07	860,003.59	41.1					367,985.47	38,579.83	2.0		813,934.84	38.1		46,068.75	3.0		VERMONT
VIRGINIA	8,962.56	2,539,832.71	166.9		28,640.23	11.1		1,210,078.10	538,360.39	39.8		2,403,273.89	158.0		165,199.05	19.0		VIRGINIA
WASHINGTON	174,624.05	2,045,600.00	94.9		26,000.00	4.6		687,862.12	116,642.49	8.7		1,994,600.00	82.8		77,000.00	16.7		WASHINGTON
WEST VIRGINIA	95,821.02	2,446,988.32	178.7	12.0	474,962.60	78.8		44,032.28	193,696.41	12.4		2,372,865.30	178.2	12.0	549,065.62	79.3		WEST VIRGINIA
WISCONSIN	2,691,353.68	4,243,708.88	395.2	14.6	60,382.00	4.6		16,606.53	50,664.71	9.3		4,084,440.62	377.4	9.2	219,650.26	22.4	5.4	WISCONSIN
WYOMING	391,616.73	1,556,727.22	200.8	66.3	5,557.00			426,380.42	471,486.00	85.3		1,604,283.53	196.8	66.3	58,000.69	5.2		WYOMING
HAWAII	787,517.82	215,195.18	9.4					97,656.00	97,440.00	6.5		215,195.18	9.4					HAWAII
TOTALS	$ 42,873,508.63	$ 155,589,430.91	14,766.4	1919.1	$ 15,698,391.39	1894.0	418.9	$ 38,889,023.58	$ 31,034,865.49	3485.8	643.6	$ 153,836,577.50	14,617.9	2027.6	$ 17,451,244.80	1842.5	310.4	TOTALS

* INCLUDES PROJECTS REPORTED COMPLETED (FINAL VOUCHERS NOT YET PAID) TOTALING: FEDERAL AID $50,879,199.26: MILES ORIGINAL 4288.1: MILES STAGE 565.2

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF PUBLIC ROADS

STATE HIGHWAY AND BRIDGE BOND STATUS, 1925

(SUBJECT TO REVISION)

8-6 (1925)
R. S. A.

STATES AUTHORIZING HIGHWAY BONDS	END FISCAL YEAR	DATES BONDS AUTHORIZED	AMOUNT OF BONDS, AS OF END OF FISCAL YEAR 1925			SOURCES FOR PAYMENTS ON HIGHWAY BONDS		REMARKS FUND USED AND BOARD APPOINTED	LAW REFERENCES AUTHORIZING BONDS
			AUTHORIZED	ISSUED	OUTSTANDING	FOR INTEREST	RETIREMENT OF PRINCIPAL		
ALABAMA	9/30	1921	$25,000,000	$ 20,000,000	$ 18,665,000	MOTOR VEHICLE FEES	MOTOR VEHICLE FEES	SINKING FUND, BOND COMMISSION	CONST. AMENDED 1921, L. 1921, ACT. 49
CALIFORNIA	6/30	1909, '15, '19	73,000,000	73,000,000	69,050,000	STATE REVENUES, FROM TAXES, ETC.	STATE REVENUES, FROM TAXES, ETC.	STATE HWY. INTEREST & SINKING FUND	CONST. AMENDED 1919 ($40,000,000)
COLORADO	11/30	1920, 1922	11,000,000	9,000,000	7,900,000	STATE TAX AND MOTOR VEHICLE FEES	STATE TAX AND MOTOR VEHICLE FEES	REDEMPTION FUND	1921, CH. 139; 1923, CH. 129
DELAWARE	12/31	1917	8,680,000	8,680,000	8,680,000	MOTOR VEHICLE FEES AND GAS. TAX	MOTOR VEHICLE FEES AND GAS. TAX		1917, CH. 63; 1921, CH. 54
IDAHO	12/31	1911-1922	3,623,500	(1) 3,787,000	(1) 3,449,500	STATE TAX (1913 ISSUE, M.V.FEES)	STATE TAX (1913 ISSUE, M.V. FEES)	REFUND BONDS IN 1925	1913, CH. 183; 1917, CH. 64; 1919, CH. 49; 1921, CH. 109
ILLINOIS	6/30	1918, 1924	160,000,000	84,000,000	84,000,000	M.V. FEES; TAX LEVY IF REQUIRED	M.V. FEES, TAX LEVY IS REQUIRED	ROAD FUND, M. V. LAW	REVISED STATUTE 1923, CHAPTER 121
LOUISIANA	12/31	1918, 1924	2,700,000	700,000	556,000	MOTOR VEHICLE FEES FROM 6 PARISHES AFFECTED BY SPECIAL HIGHWAY.	M. V. FEES FROM 6 PARISHES AFFECTED BY SPECIAL HIGHWAY.	ST. BD. OF LIQUIDATION OF DEBT	1918, ACT 18; 1924, ACT 179
MAINE	6/30	1913-1923	16,447,000	10,442,500	9,500,000	MOTOR VEHICLE FEES	MOTOR VEHICLE FEES		1913, CH. 130; 1919, C. 251; 1921, C. 131; 1923 C. 92; 1925, CH. 203, 215.
MARYLAND	9/30	1908-1924	35,157,000	33,732,000	24,454,000	STATE TAX	STATE TAX	HWY. & BRIDGE BOND SINKING FUND	LAWS 1908, '10, '12, '14, '16, '18, '20, '22, '24
MASSACHUSETTS	11/30	1894-1915	16,250,000	11,767,000	(2) 8,097,500	STATE REVENUES & M.V. FEES	STATE REVENUES & M. V. FEES		LAWS 1894, 1904, 1916
MICHIGAN	6/30	1919	50,000,000	(1) 53,419,000	(1) 50,000,000	STATE TAX & MOTOR VEHICLE FEES	STATE TAX & MOTOR VEHICLE FEES	HWY. IMPROVEMENT LOAN BOARD	CONST. AMEND. 1919; L. 1919, ACT 25
MINNESOTA	3/30	1919, 1923	75,000,000	(3) 33,339,708	(3) 33,339,700	M. V. FEES; TAX LEVY IF REQUIRED	M. V. FEES; TAX LEVY IF REQUIRED	TRUNK HIGHWAY SINKING FUND	CONST. AMEND. 1920; GEN. STAT. 1923
MISSOURI	12/31	1920	60,000,000	40,000,000	35,000,000	" " " " " "	" " " " " "	ST. ROAD BOND INT. & SINK. FUND	CONST. AMENDED 1921; LAWS 1921
NEVADA	12/31	1919	1,000,000	900,000	600,000	MOTOR VEHICLE FEES	MOTOR VEHICLE FEES	CONSOL. BOND INT. & RED. FUND	LAWS 1919
NEW HAMPSHIRE	6/30	1912	225,000	225,000		STATE HWY. FUND (BY STATE APPROP)	STATE HWY. FUND (BY STATE APPROP.)	STATE REVENUES, INCL. M.V. FEES	L. 1911, CH. 182 (ALL RETIRED IN 1925)
NEW JERSEY	6/30	1920, '22, '24	76,000,000	45,000,000	45,000,000	STATE TAX	STATE TAX	SINKING FUND	1920, CH. 352; 1922, CH. 262; 1924, CH. 262
NEW MEXICO	6/30	1912, '21	2,500,000	2,500,000	2,340,000	STATE TAX	STATE TAX	SINKING FUND, AFTER 1926	1912, CH. 58; 1921, CH. 167
NEW YORK	6/30	1906, '12	100,000,000	100,000,000	98,400,000	STATE REVENUES	STATE REVENUES	SINKING FUND	1906, 1912
NORTH CAROLINA	6/30	1921, '23	65,000,000	59,999,600	59,999,600	STATE HWY. FUND (INCL. M.V. & GAS TAX)	STATE HWY. FUND (INCL. M.V. & GAS TAX)		1921, CH. 2; 1923, CH. 263
OREGON	9/30	1917, '21	39,200,000	(1) 41,700,000	(1) 37,263,750	" " " " " " "	" " " " " " "		1917, CH. 175, 423; 1919, CH. 173; 1921 CH. 31, 43, 383
PENNSYLVANIA	12/31	1919, 1925	100,000,000	85,367,000	83,255,000	STATE REVENUE (M.V. FEES AFTER '25)	STATE REV. (M. V. FEES AFTER 1925)	BOARD OF FINANCE & REVENUE	1919, ACT 50; 1925, ACT 16
RHODE ISLAND	11/30	1906-1923	3,100,000	3,100,000	3,063,000	STATE REVENUES	STATE REVENUES		LAWS 1907, 1909, 1917, 1920, 1923
SOUTH DAKOTA	6/30	1919, 1921	6,000,000	6,000,000	5,650,000	STATE TAX LEVY	STATE TAX LEVY		1919, CH. 334; AMEND. 1921, CH. 395
UTAH	11/30	1911-1921	7,260,000	7,260,000	7,260,000	STATE REV., M. V. FEES & GAS. TAX	STATE REV., M. V. FEES & GAS. TAX		1911, CH. 45; 1917, C. 32; 1919, C. 59; 1921, CH. 64
WEST VIRGINIA	6/30	1920 -1925	50,000,000	41,000,000	41,000,000	STATE TAX, M.V. FEES & GAS. TAX	STATE TAX, M.V. FEES & GAS. TAX	STATE ROAD SINKING FUND	CONST. AMEND. 1920; 1921, C. 113; 1923, CH. 4; 1925, CH. 13
WYOMING	9/30	1919, 1921	4,600,000	4,600,000	2,400,000	STATE TAX	MOTOR VEHICLE FEES		1919, CH. 195; 1921, CH. 97.
TOTALS			991,742,500	779,518,808	738,923,050				

NOTES: (1) INCLUDES REFUND BONDS (2) 1924 DATA USED (3) 1924 TOTAL OF COUNTY BONDS, ASSUMED BY STATE AS OBLIGATIONS.

BUREAU PREPARING AN EXHIBIT FOR THE AMERICAN ROAD BUILDERS ASSOCIATION CONVENTION

The Bureau is preparing an educational exhibit for display at the coming convention of the American Road Builders Association which is to be held in Chicago from January 10 to 14, 1927. The main display of the Bureau will occupy a floor space of approximately 2,500 square feet and will be located in the ball room of the Coliseum on South Wabash Avenue. Another smaller exhibit, which will consist of three standard exhibit booths, will be located in the foyer of the Palmer House - the official convention headquarters.

The main exhibit presents a view of the results of experience and research in highway construction, accumulated in recent years, on which the new science of highway engineering is founded.

Entering the exhibit the visitor finds himself in the office of the highway commission of the State of Utopia, typifying the ideal highway construction agency, the operations of which have produced a system of Utopian highways every mile of which is improved to the complete satisfaction of every taxpayer.

The Commission's operations are conducted solely on the basis of rational principles developed out of the experience of the past and in harmony with the conclusions of research, uninfluenced by considerations of politics and expediency.

After a further explanation of the happy solution of the highway problem in Utopia the visitor will pass into a large room around the walls of which are arranged in horseshoe form nine exhibit booths. These booths illustrate the successive steps taken by the Utopian State highway commission to locate, build, maintain and operate a successful system of State highways. The booths are entitled: Traffic Surveys, Highway Financing, Subgrade Surveys, Grading Economy, Stage Construction, Construction Certainty, Pavement Planning, Efficient Concrete Mixing, and Traffic Service.

From the main room in which the booths are located the visitor passes into a discussion room on the walls of which are hung bromide enlargements of the several booths. There, an attendant will be present to answer any questions that may have occurred to the visitor and to present him with an illustrated

booklet describing the subject matter of the entire exhibit. Copies of this booklet will be furnished to district engineers upon request.

The smaller exhibit in the foyer of the Palmer House will consist of three standard booths titled: The Federal-Aid Highway System Of The United States, Taxation Without Representation, and Roads From Savagery To Civilization.

MODULUS OF RUPTURE BY CANTILEVER BEAM TESTS

Contributed by the Division of Tests

A simple device for testing cantilever beams in order to determine the modulus of rupture has given a great impetus during the past year to the field testing of concrete. There is no doubt of the saving in time and equipment made possible by the use of cantilever-beam specimens both in the field and in the laboratory. But the effect upon the test results of the numerous and novel methods of gripping the specimen and applying the load is practically unknown.

With the idea of supplying information relative to this test, an outline covering a variety of methods has been drawn up by the Division of Tests. In accordance with this program, specimens are to be compared as to strength and uniformity. Five or more specimens will be tested by each method. It is expected that fairly close comparisons may be made as to the suitability of the several methods since unusual precautions are being taken to insure a uniform quality in the concrete beams.

At present a number of the specimens have been made up and some of them have been tested. The data secured up to this time are not sufficient to give an indication of the probable outcome of the completed tests. As the study progresses additional methods undoubtedly will be suggested and included in the investigation.

MOTOR TRUCK IMPACT TESTS NOW IN PROGRESS

Contributed by James A. Buchanan of the Division of Tests.

A special series of field motor-truck impact tests, now being carried on by the Division of Tests, is expected to be completed within a few months. The objectives of these tests were determined from a study of the data secured during the original program which has been completed. The present work also is in cooperation with the Society of Automotive Engineers and the Rubber Association of America.

Based upon the findings of the original program, it is believed that motor truck impact reactions are dependent on four major variables, namely; road roughness, tire equipment, wheel load and vehicle speed. It is not believed that the effect of one variable should be considered without due regard for the other three. From the original program it was possible to plot lines of equal impact reaction for one road condition, four tire types, and various combinations of load and speed. The result was a series of isodynamic curves from which could be read the maximum total vertical reactions in thousands of pounds that might be reasonably expected to occur on that particular road for any combination of wheel load and truck speed. The data were segregated by tire types such as pneumatic, new cushion, new solid, and worn-out solid equipment; and the curves represented a range of wheel loads from 0 to 20,000 pounds and speed from 0 to 30 miles an hour. The tests were made on the Arlington test road which had been roughened by artificial obstructions.

With this preliminary isogram as a basis, a program of tests was formulated, the field work of which is expected to be completed within a few months. A number of highway sections have been selected as representative in type and roughness. These sections were marked off in one-twentieth mile lengths and points were spotted on the pavement with traffic white to guide the trucks over the test sections. The road sections were calibrated carefully at varying speeds by means of the "roughometer" described in the September, 1926, number of Public Roads. The roughness limits were approximately 100 and 800 units at a speed of 30 miles an hour.

Tire equipment was selected to represent the four types used in the preliminary investigation, namely; pneumatic, new cushion, new solid, and worn-out solid. The average deflections of the four types under a static load of 10,000 pounds were approximately 2.5 inches, 1.0 inch, 0.7 inch, and 0.2 inch respectively. The

TIRES WERE MOUNTED PERMANENTLY ON EXTRA WHEELS IN ORDER THAT TIRE CHANGES MIGHT BE MADE RAPIDLY AND CONVENIENTLY BY SUBSTITUTING WHEELS.

AT THE BEGINNING OF THE TESTS, THE REAR-WHEEL LOADS WERE STANDARDIZED AT 2,500, 5,000, 7,500 AND 10,000 POUNDS. TWO TRUCKS WERE USED, A 2-TON TRUCK FOR THE 2,500 AND 5,000 POUND LOADS AND A 5-TON TRUCK FOR THE OTHER LOADS. THE LIGHT LOAD OF EACH TRUCK WAS ACCURATELY MEASURED ON PLATFORM SCALES AND SECURELY FASTENED IN POSITION. THEN THE HEAVIER LOAD WAS BUILT UP ON EACH TRUCK BY ADDING 100-POUND LEAD OR IRON WEIGHTS. THE POSITIONS OF THESE EXTRA WEIGHTS WERE MARKED ON THE TRUCKS SO THAT THE WHEEL LOADS MIGHT BE DUPLICATED READILY.

THE TRUCKS WERE OPERATED AT SPEEDS VARYING BY SMALL INCREMENTS FROM THE MINIMUM UP TO THE MAXIMUM SPEED OBTAINABLE. THE AVERAGE SPEED OF EACH RUN WAS COMPUTED FROM STOP-WATCH OBSERVATIONS AND THE KNOWN LENGTH OF THE TEST SECTION. VARIATIONS IN SPEED WERE OBSERVED FROM SPEEDOMETERS MOUNTED ON THE TRUCKS. RUNS VARYING FROM THE AVERAGE SPEED BY MORE THAN 1/2 MILE PER HOUR AS REGISTERED IN THE SPEEDOMETER WERE DISCARDED.

A FIELD TEST PROGRAM OF THIS CHARACTER MADE NECESSARY A MOBILE ORGANIZATION AND EQUIPMENT. TO PROVIDE FOR THIS, A FIELD OFFICE AND TWO LOADING AND STORAGE PLATFORMS WERE BUILT ON A 16-FOOT, THREE-TON-TRAILER CHASSIS. ON A 2-TON TRUCK CHASSIS, A SPECIAL PLATFORM BODY WAS CONSTRUCTED WITH A SWINGING CHAIN HOIST PLACED AT THE FORWARD END. IN ADDITION TO HAULING THE TRAILER, THIS SERVICE TRUCK WAS USED TO CARRY THE SPARE WHEELS, GASOLINE, AND GENERAL EQUIPMENT NECESSARY FOR THE TESTS.

THE 2-TON AND 5-TON TEST TRUCKS WERE EQUIPPED WITH THE COIL-SPRING ACCELEROMETERS DEVELOPED BY THE BUREAU, WHICH WERE MOUNTED SO AS TO FOLLOW THE VERTICAL MOTION OF THE RIGHT REAR WHEELS. IN FIGURE 1 THE FOUR PIECES OF ROLLING STOCK JUST DESCRIBED ARE SHOWN PARKED ON A VACANT LOT NEAR ONE GROUP OF THE TEST SECTIONS. THE TWO MOTORCYCLES WERE USED BY LOCAL TRAFFIC OFFICERS.

MUNICIPAL AUTHORITIES IN THE DISTRICT OF COLUMBIA AND IN ALEXANDRIA, VIRGINIA, WERE INTERESTED COOPERATORS IN THE TESTS MADE WITHIN THEIR JURISDICTION. TRAFFIC OFFICERS WERE ASSIGNED TO ASSIST IN THE WORK AND THEY WERE EXTREMELY VALUABLE IN MAKING IT POSSIBLE TO CONDUCT THE TESTS ON THE STREETS WITH SAFETY. NO-PARKING SIGNS WERE PLACED TEMPORARILY AT SEVERAL POINTS TO FACILITATE THE TESTS.

FIGURE 1. - THE EQUIPMENT USED IN THE SPECIAL IMPACT TESTS OF THE BUREAU. ON THE LEFT ARE THE 2 AND 5-TON TEST TRUCKS. IN THE CENTER IS THE TRAILER EQUIPPED WITH A FIELD OFFICE AND TWO LOADING AND STORAGE PLATFORMS. ON THE RIGHT IS THE SERVICE TRUCK ON WHICH IS MOUNTED A CHAIN HOIST FOR CHANGING TIRES. THE MOTORCYCLES WERE USED BY LOCAL TRAFFIC OFFICERS.