Survey of Current Practices of Using Falling Weight Deflectometers (FWD)

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ABSTRACT
In May of 2001, the Florida Department of Transportation (FDOT) distributed a survey questionnaire to 51 State Departments of Transportation (DOT), including Puerto Rico, and to three Canadian provinces highway agencies including British Columbia, Ontario, and Quebec. The objective was to assess the current practices of using the Falling Weight Deflectometer (FWD) by these highway agencies, and to gather some related facts and figures of interest to FWD users. The questionnaire targeted three FWD related program areas including Field Operations, Pavement Design Parameters, and Program Management.

A total of 39 responses were received representing a 71% response rate. The survey results show 81 % of the responding agencies manage their FWD testing program in-house, and the rest of the agencies outsource their work. Seventy percent of the agencies use Dynatest units, 11% use JILS units, 8% use KUWAB units, and 8% own and operate a combination of units. Seventy eight percent of the respondents use the FWD at the project level, while 19% use it at both project and network levels. As an average percent of FWD program areas, 63 % of the testing is dedicated to structural evaluation, 16% for investigative, 18 % for research, and the rest for other type of work. Seventy two percent of the agencies have a Quality Control/Quality Assurance plan in effect. Fifty seven percent use 1 crewmember per unit, 16% use two crewmembers, and 22% reported that the number varies. Seventy percent of the agencies typically use a seven-sensor configuration during testing, 23% use nine sensors, and 3 % use 6 sensors. Sixty nine percent of the FWD units operate under DOS, and 22 % operate under a Windows environment. Sixty nine percent of the agencies use the Resilient Modulus from the FWD data to estimate subgrade strength, while 25% use some other means. Twenty eight percent of the agencies reported using a seasonal and/or temperature adjustment factor(s) in determining the effective subgrade modulus, and 64 % did not.

EXECUTIVE SUMMARY

In May of 2001, the Florida Department of Transportation (FDOT) distributed a survey questionnaire to the 51 State Departments of Transportation (DOTs), and to 3 Canadian provinces including British Columbia, Ontario, and Quebec. The objective was to assess the current practices of using the Falling Weight Deflectometer (FWD) by these highway agencies, and to gather some related facts and figures of interest to FWD users. This report provides a summary of the survey results based on the responses received from the user agencies.

BACKGROUND

Because of the speed and ease of operation, deflection-based techniques are being widely used in the evaluation of the structural integrity and the estimation of the elastic moduli of in-place pavement systems. Deflections can be non-destructively induced and measured using different commercially available devices. The more commonly used devices are generally categorized into two types depending on how the load is applied to the pavement system. Vibratory devices, such as Dynaflect, apply a steady-state sinusoidal load, while those known as impact or falling weight devices apply an impulse load to the pavement. In recent years, the Falling Weight Deflectometer device, commonly known as the FWD, is gaining more acceptance among highway agencies because of its versatility, reliability, and ease of use. It is also believed that FWD loading better simulates the effects of traffic on pavement structures. It consists of a trailer mounted with a falling weight system capable of loading a pavement in a manner that simulates, in both magnitude and duration, actual wheel loads. An impulse load is generated by dropping a weight mass from a specified height. The mass is raised hydraulically, then released by an electrical signal and dropped with a buffer system on a 12-inch (300-mm) diameter rigid steel plate. A thin, hard rubber pad rests between the plate and the pavement surface to allow for an even load distribution. The resulting pavement deformations are picked up through a series of sensors located along the centerline of the trailer. The deflection measurements are recorded by the data acquisition system located in the tow vehicle. Figure 1 gives an illustration of such a device.

The present report summarizes the results of a survey of the current practices of FWD users.

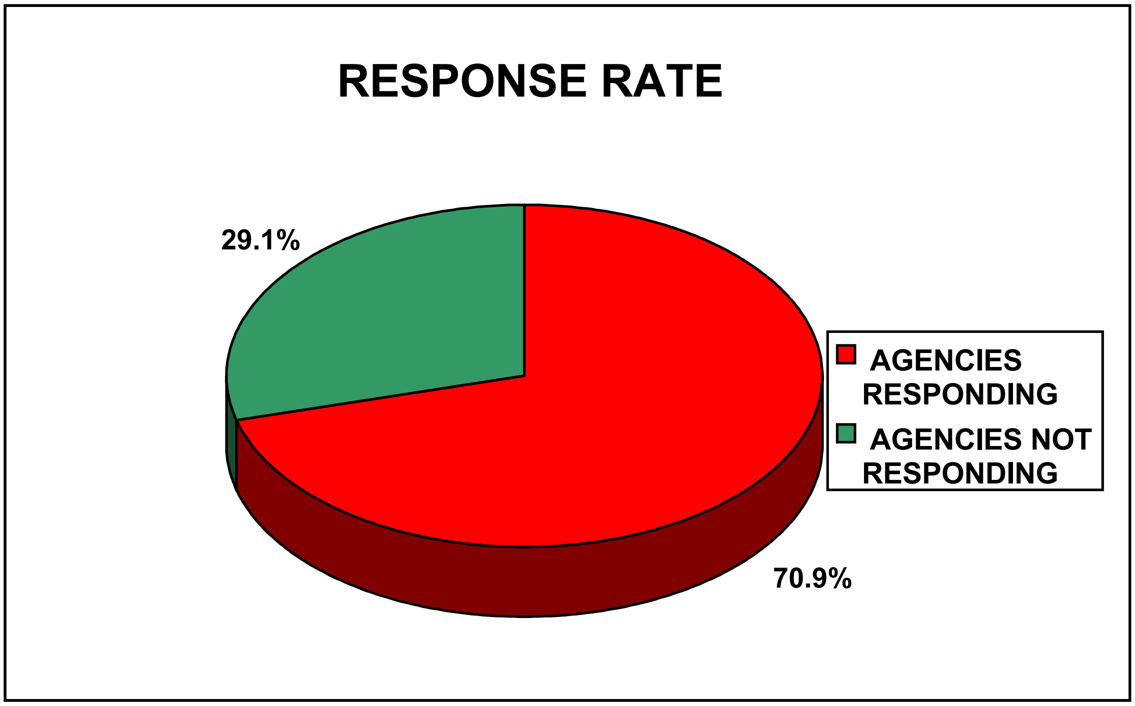
Figure 1 Falling Weight Deflectometer, Dynatest 8000.

OBJECTIVE

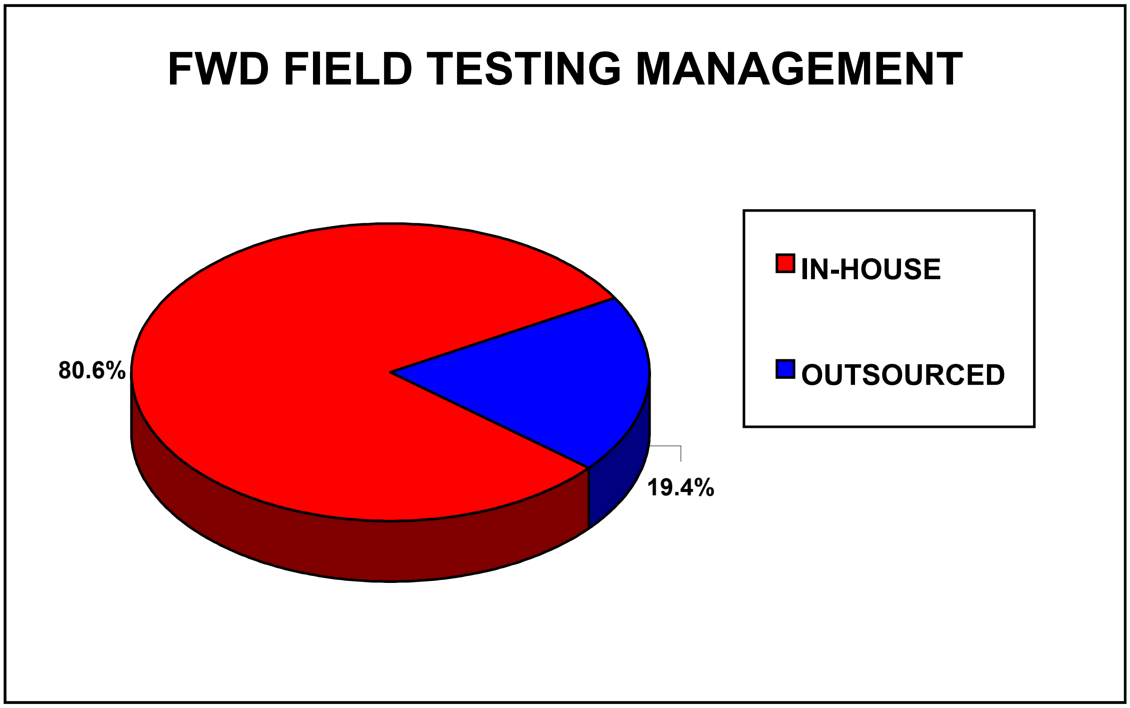
The purpose of this study is to assess the current practices of using the FWD by governmental agencies, and to gather some related facts and figures of interest to FWD users.

SURVEY DATA ANALYSIS

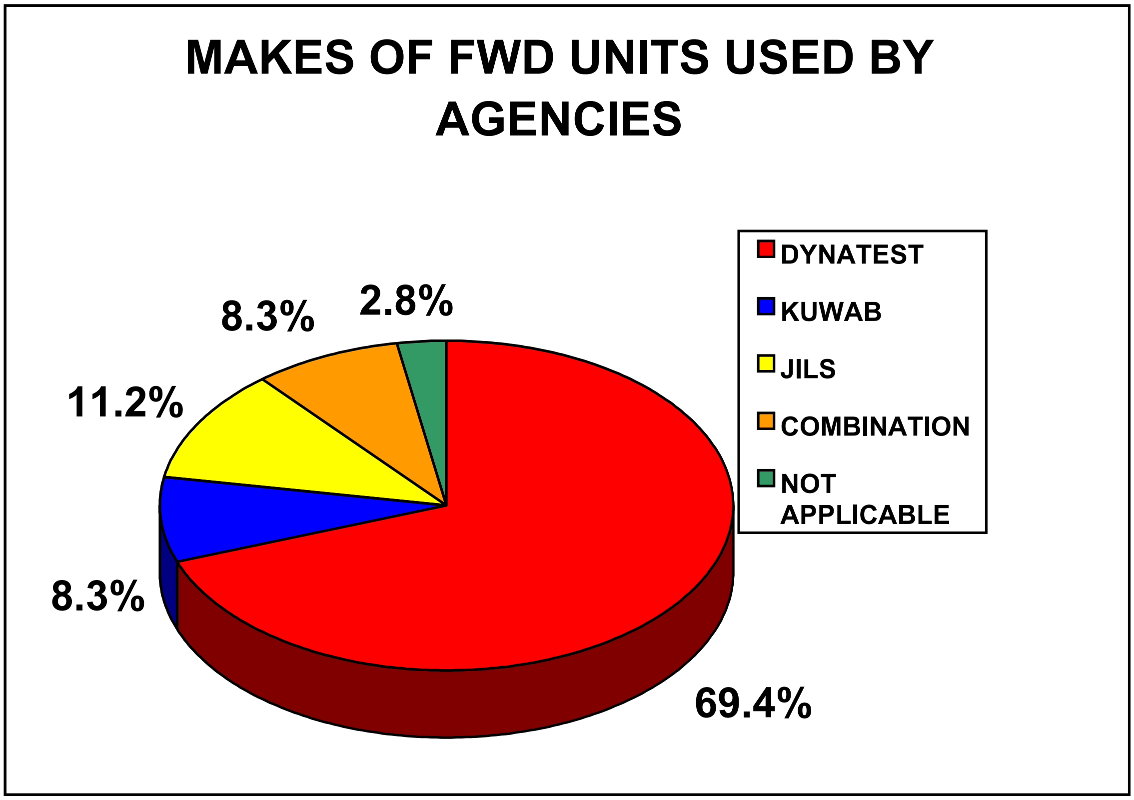
A total of 39 responses were received representing a 71% response rate. Of these 39 responses, 36 responses were received from State DOTs, two responses from British Columbia - representing the Northern region, BC (N), and the Southern region, BC (S)-, and one response from Ontario. The State of Connecticut has a proposed FWD program, which was not implemented at the time of this survey. Respondents from the States of Delaware and Hawaii indicated that they did not make use of the FWD. The results from this survey are based on the information provided by the responding user agencies, and are summarized in the following pages according to the three FWD program areas addressed in the survey, namely 1) FWD Program Management, 2) FWD Operation, and 3) Pavement Design Parameters.



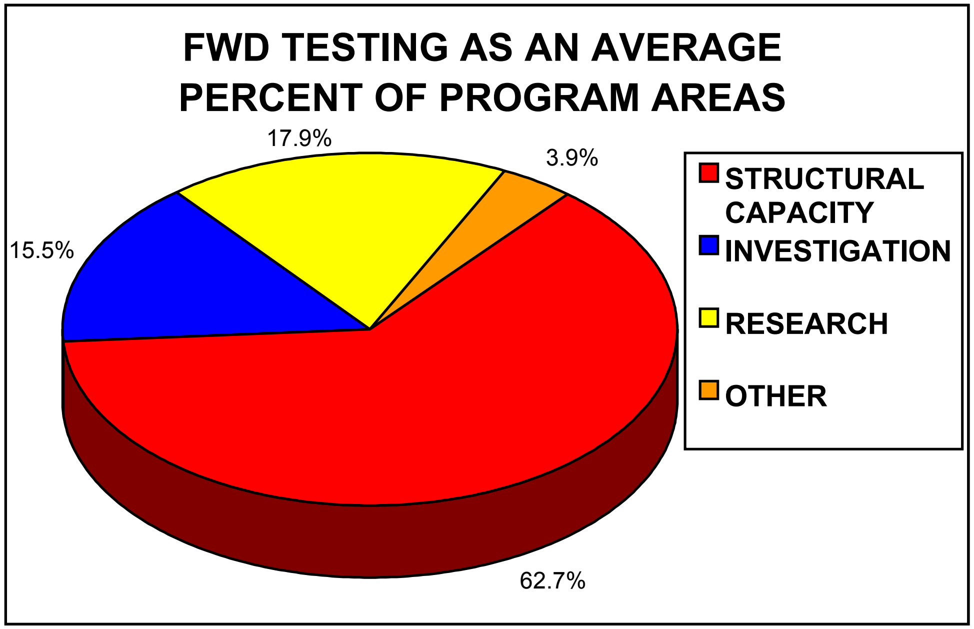
AGENCIES RESPONDING			AGENCIES NOT RESPONDING	
AZ	KY	ON	AL	NH
BC(N)	ME	PA	AK	NM
BC(S)	MN	PR	AR	OH
CT	MD	SC	CA	OK
DE	MI	SD	CO	OR
FL	MS	TN	LA	RI
GA	MO	TX	MA	WY
HI	MT	UT	NE	
ID	NV	VA		
IL	NJ	VT		
IN	NY	WA		
IA	NC	WV		
KS	ND	WI		
39			**16**	



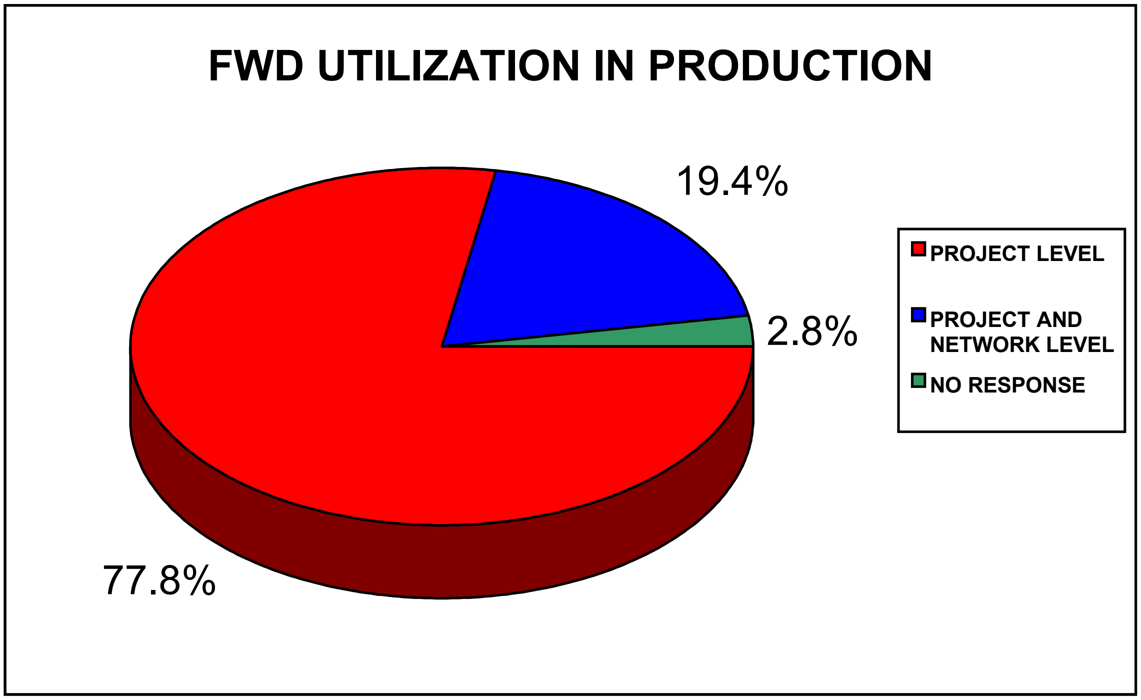
IN-HOUSE		OUTSOURCED (%)
AZ	MT	ID (5)
BC(N)	NV	MD (5)
BC(S)	NY	NJ (90)
FL	NC	ON (100)
GA	ND	TX (2)
IL	PA	UT (2)
IN	PR	WI (10)
IA	SC	
KS	SD	
KY	TN	
ME	VA	
MN	VT	
MI	WA	
MS	WV	
MO		
29		**7**



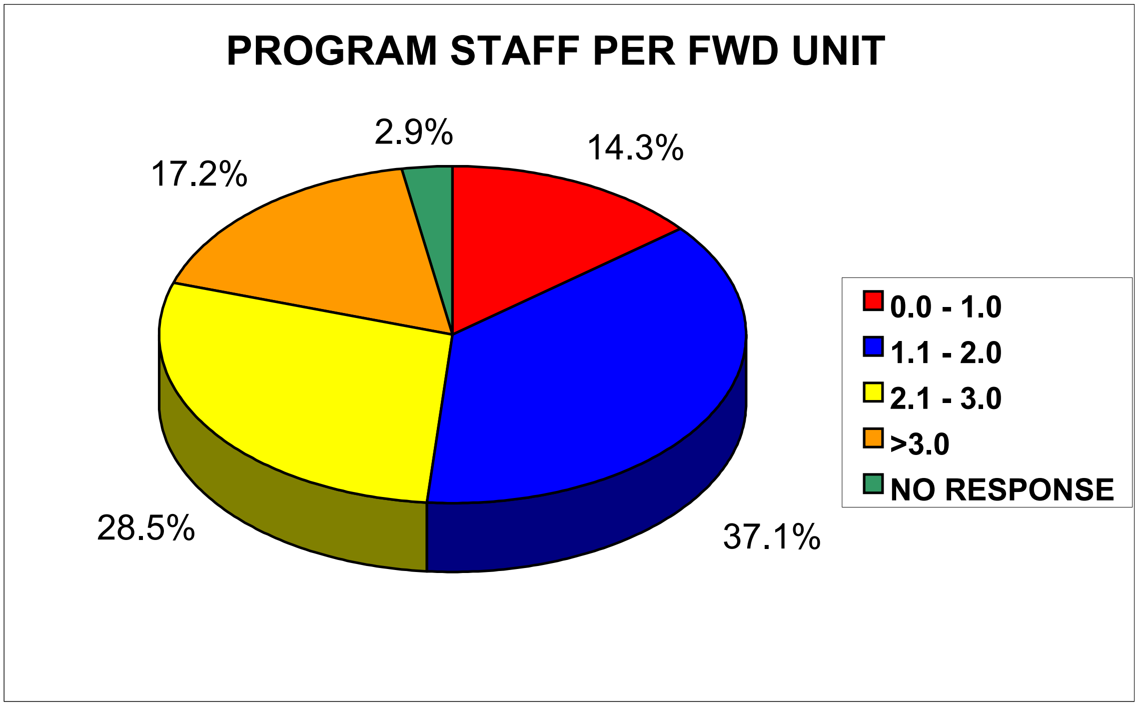
DYNATEST		KUWAB	JILS	COMBINATION	NOT APPLICABLE
BC(N)	NJ	MI	IA	AZ	ON
BC(S)	ND	PA	KY	NY	
FL	PR	WI	ME	NC	
GA	SC		MT		
ID	SD				
IL	TN				
IN	TX				
KS	UT				
MD	VA				
MN	VT				
MS	WA				
MO	WV				
NV					
25		**3**	**4**	**3**	**1**



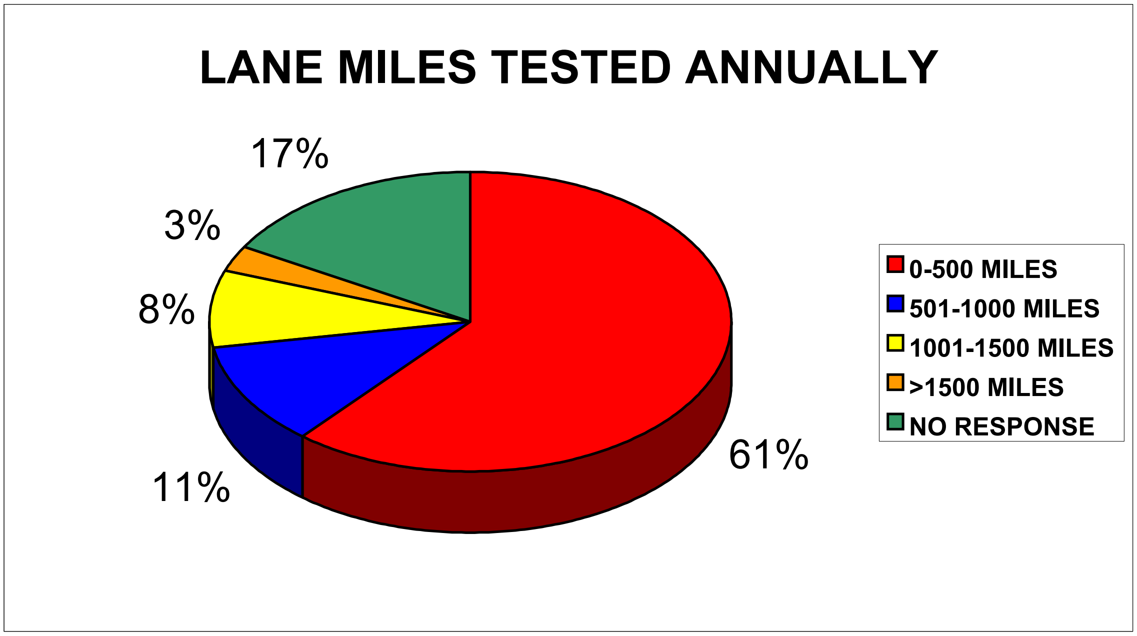
PERCENT OF PROGRAM AREAS				
AGENCY	STRUCTURAL CAPACITY	INVESTIGATION	RESEARCH	OTHER
AZ	85	10	5	0
BC(N)	90	0	5	5
BC(S)	90	10	0	0
FL	75	10	10	5
GA	30	50	20	0
ID	95	0	0	5
IL	45	5	50	0
IN	30	20	20	30
IA	75	0	25	0
KS	95	2	3	0
KY	25	25	50	0
ME	80	20	0	0
MD	85	10	5	0
MI	25	10	65	0
MN	25	25	50	0
MS	75	5	20	0
MO	35	65	0	0
MT	90	5	5	0
NV	70	10	10	10
NJ	10	0	10	80
NY	10	10	80	0
NC	75	20	5	0
ND	70	10	20	0
ON	90	10	0	0
PA	89	0	10	1
PR	95	0	5	0
SC	80	10	10	0
SD	80	10	10	0
TN	30	30	40	0
TX	65	15	10	5
UT	80	5	15	0
VA	50	25	25	0
VT	60	10	30	0
WA	90	5	5	0
WV	90	0	10	0
WI	0	100	0	0



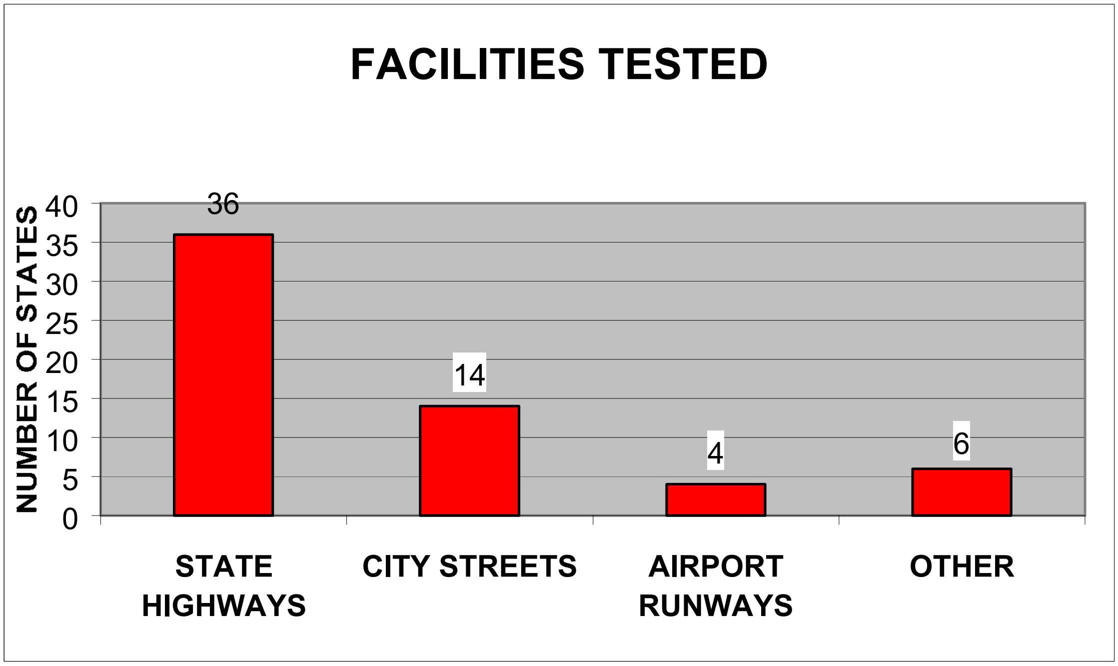
PROJECT LEVEL				PROJECT AND NETWORK LEVEL	NO RESPONSE
BC(N)	KY	NV	SC	AZ	
BC(S)	ME	NY	TN	IL	
FL	MD	NC	VA	MT	
ID	MN	ND	VT	NJ	
IN	MI	ON	WA	SD	
IA	MS	PA	WV	TX	
KS	MO	PR	WI	UT	
28				**7**	**1**



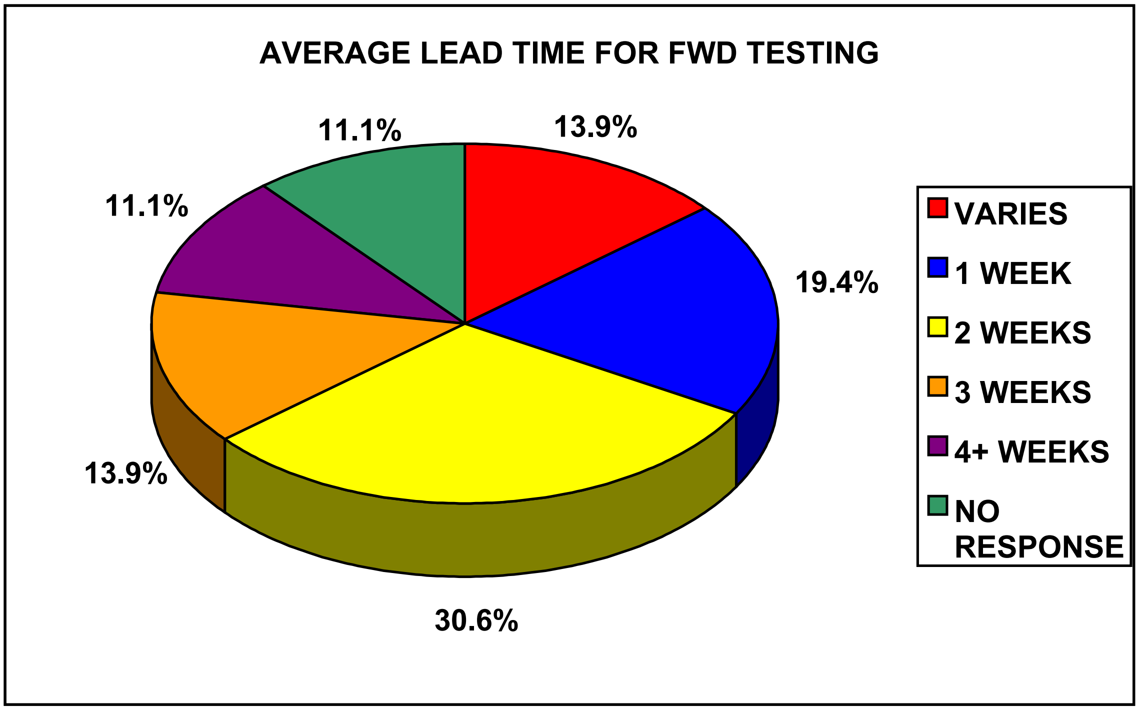
NOTE: Program Staff includes FWD operators, Engineers, In-house Consultants, and other Assistants.



0-500 MILES		501-1000 MILES	1001-1500 MILES	>1500 MILES	NO RESPONSE
AZ	NY	AZ	FL	TX	
BC(N)	NC	ID	KS		
BC(S)	ND	IN	SD		
IL	PR	UT			
IA	SC				
ME	TN				
MD	VA				
MI	VT				
MS	WA				
MT	WV				
NV	WI				
22		**4**	**3**	**1**	**6**



AGENCY	STATE HIGHWAYS	CITY STREETS	AIRPORT RUNWAYS	OTHER	AGENCY	STATE HIGHWAYS	CITY STREETS	AIRPORT RUNWAYS	OTHER
AZ	X				NV	X	X		
BC(N)	X				NJ	X	X		X
BC(S)	X				NY	X			
FL	X				NC	X		X	
GA	X				ND	X	X		
ID	X	X			ON	X			
IL	X	X	X	X	PA	X	X		
IN	X	X		X	PR	X	X		
IA	X				SC	X	X		
KS	X				SD	X	X	X	
KY	X	X			TN	X			X
ME	X	X			TX	X		X	
MD	X	X			UT	X			
MN	X				VA	X			
MI	X	X			VT	X			X
MS	X				WA	X			X
MO	X				WV	X			
MT	X				WI	X			


AVERAGE LEAD TIME FOR FWD TESTING
11.1%
13.9%
11.1%
19.4%
13.9%
30.6%
VARIES
1 WEEK
2 WEEKS
3 WEEKS
4+ WEEKS
NO RESPONSE

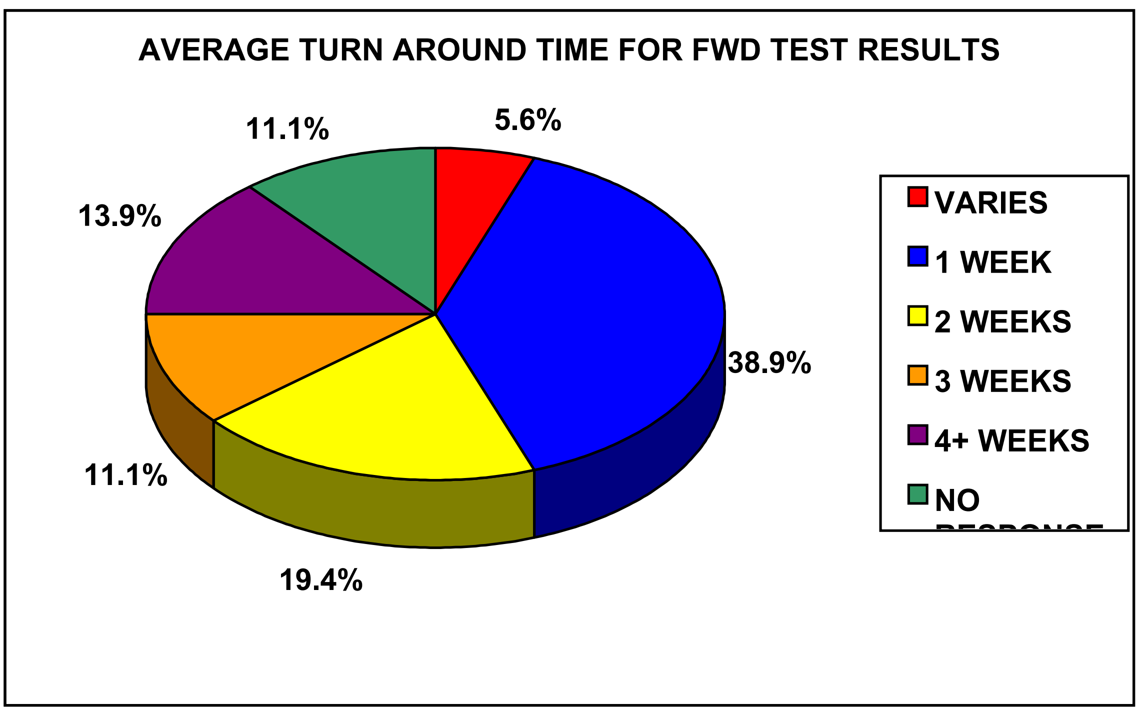

AVERAGE TURN AROUND TIME FOR FWD TEST RESULTS
11.1%
5.6%
13.9%
38.9%
11.1%
19.4%
VARIES
1 WEEK
2 WEEKS
3 WEEKS
4+ WEEKS
NO

TABLE 1A FWD Operating Budget And Maintenance of Traffic

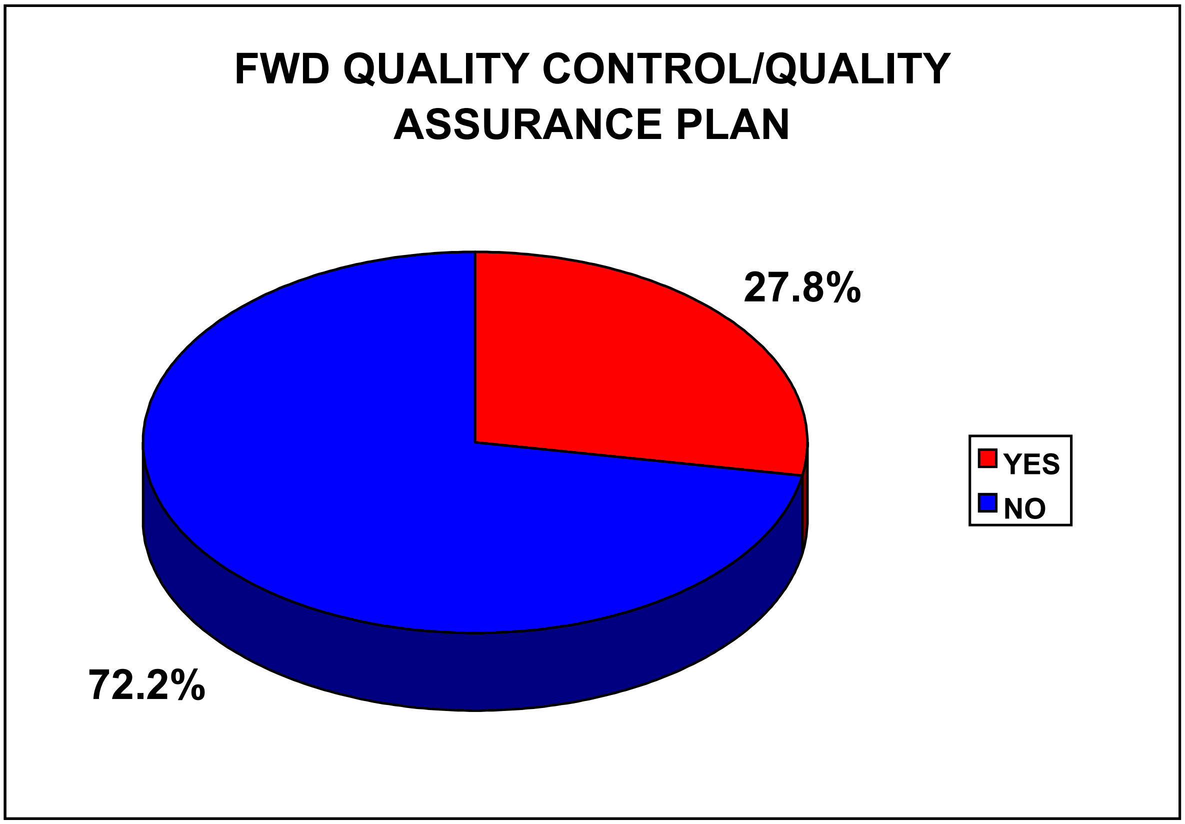
AGENCY	PROJECT INFORMATION		AVERAGE OPERATING BUDGET PER LANE MILE	MAINTENANCE OF TRAFFIC		
	NUMBER OF PROJECTS	NUMBER OF LANE MILES		IN-HOUSE STAFF	DOT MAINTENANCE	CONSULTANT/ CONTRACTOR
AZ	25	500	do not separate costs	X	X	X
BC(N)	12	250	$286	X		X
BC(S)	20	400	$550	X		X
FL	165	1135	$203		X	
GA	no information given		no information given		X	
ID	40	600-700	$385	X		
IL	50~60	100-125	$478		X	
IN	50	700	$171	X	X	
IA	new unit - no testing done yet		unknown	X	X	
KS	70	1400	$71	X		
KY	15		$50,000, 15 projects tested		X	
ME	50	120	no information given	X	X	
MD	150	300	charged to design project budget		X	X
MI	12	70	no information given	X	X	X
MN	233	975	not available		X	
MS	25	500			X	
MO			$50,000, no project info given	X		
MT	40	350	$429	X		
NV	20	400	$75	X		
NJ	no information given				X	X
NY	100	18	$269		X	
NC	70	280	unknown		X	X (infrequent)
ND	0	300	$267	X		
ON	4-5					X
PA	250				X	
PR	34	400	$160	X		
SC	25	300	not specifically budgeted		X	
SD	60	1500	$27	X		
TN	20	120	not yet established		X	
TX	250-500	5,000-15,000	$28		X	
UT	10~20	1000	$130	X	X	X
VA	20	250	no information given		X	
VT		60	$2,500		X	
WA	30	200	$61		X	
WV	50	200	no information given	X	X	
WI	10	100	$300			X

TABLE 1B FWD Customers And Services Provided

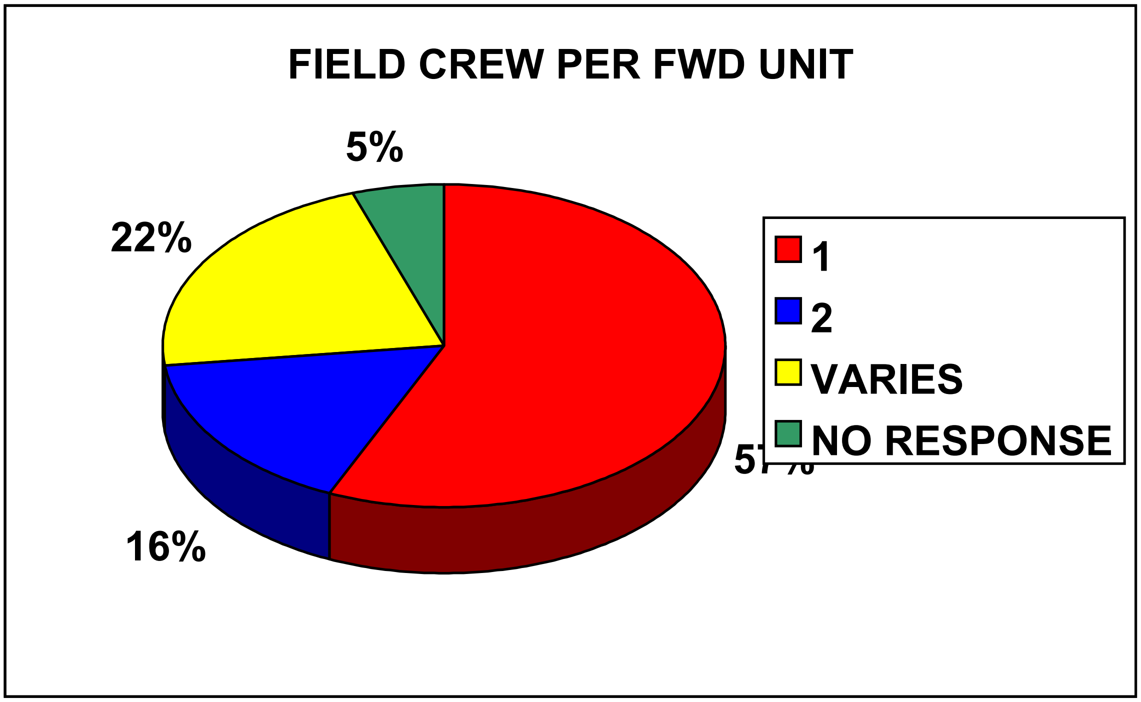
	FWD PROGRAM MANAGEMENT CUSTOMERS AND INFORMATION/SERVICES PROVIDED			
AGENCY	DESIGN	MAINTENANCE	CONSTRUCTION	OTHER
AZ	FWD results			FWD results
BC	overlay requirements and rehab		quality control	
BC	new construction	surface rehab designs	quality control	
FL	subgrade resilient modulus		investigation	research, testing support, pavement performance
GA			investigation and analysis	
ID	pavement evaluation, design information	deflection data		
IL	design overlays			research data collection
IN	rehab strategy, subgrade stiffness, pavement stiffness	undersealing locations, load transfer across joints and cracks	effectiveness of rubblization	data for research
IA	not determined yet			
KS	pavement design for project level rehab. information			pavement management system for project optimization of substantial maintenance projects
KY	structural evaluations and overlay design			
ME	subgrade modulus and overlay thickness	check subgrade moduli when desired density not reached		
MD	pavement recommendation. - new and rehab	pavement recommendation - emergency repair	pavement recommended - construction related	research or material investigation
MN	no specific information provided			research, seasonal; and annual deflections for MnRoad
MI	subgrade resilient modulus			University - variety of FWD data, deflection basin, time/history, joint/crack efficiencies
MS	overlay thickness design	joint load transfer efficiency analysis		University researchers as needed
MO	load transfer checks on pavement and bridge approach slabs			
MT	resilient modulus values			pavement management
NV	pavement condition, cores, with overview of condition of project at the time of testing			
NJ				capital investment strategies

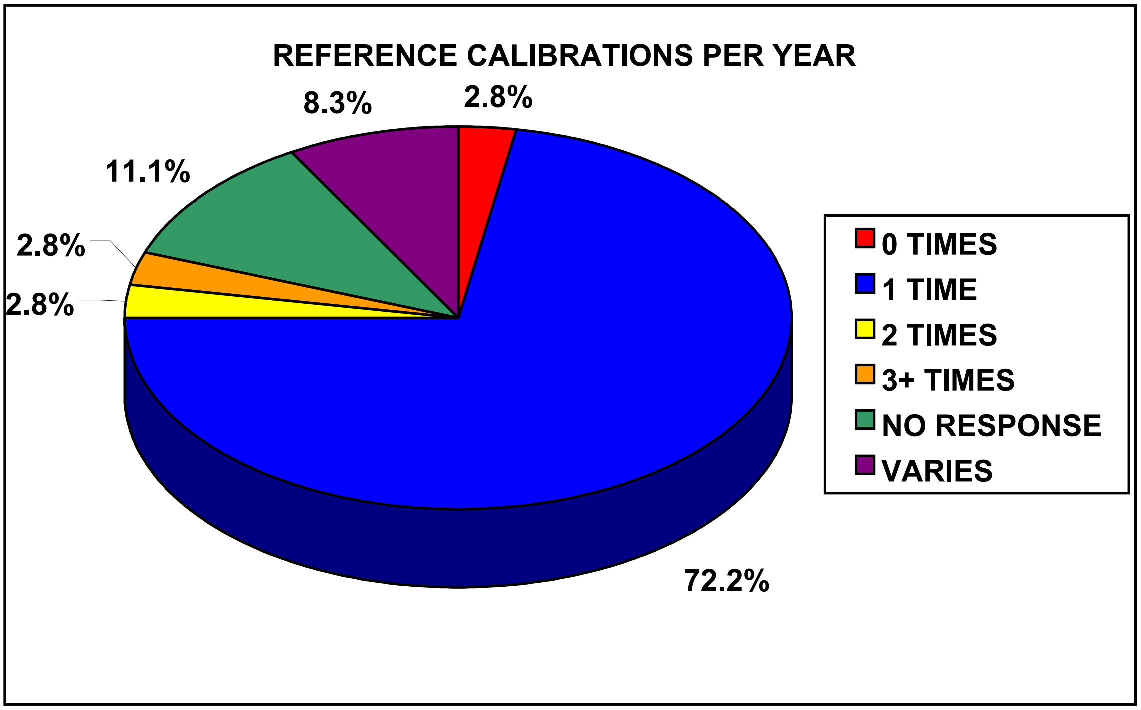
TABLE 1B FWD Customers And Services Provided

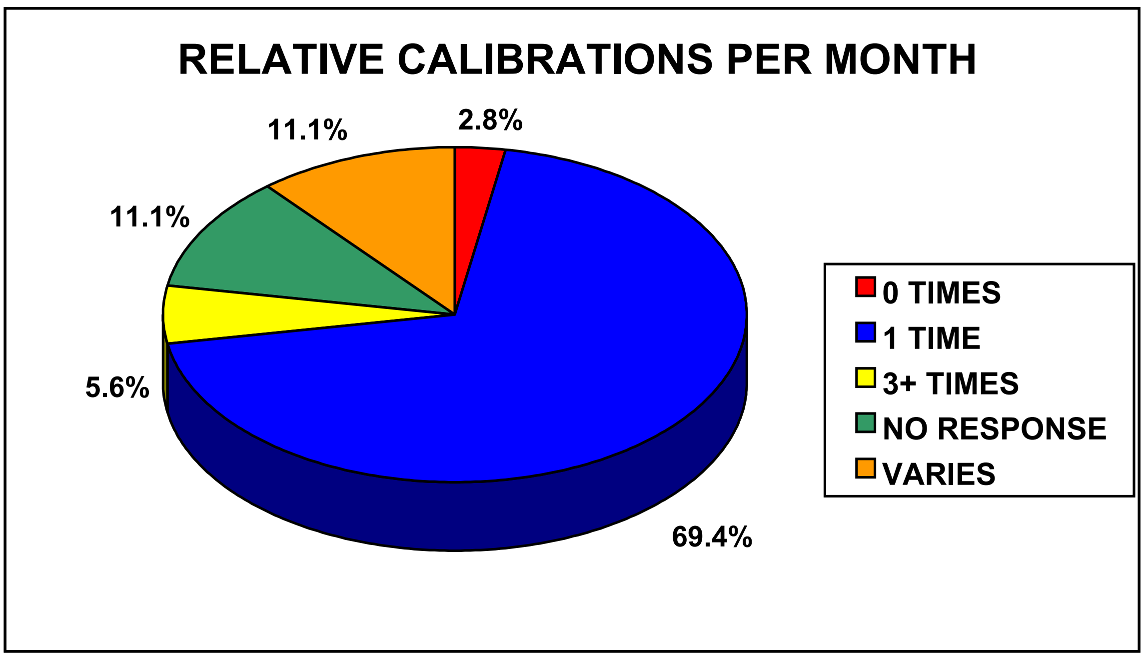
	FWD PROGRAM MANAGEMENT CUSTOMERS AND INFORMATION/SERVICES PROVIDED			
AGENCY	DESIGN	MAINTENANCE	CONSTRUCTION	OTHER
NY	subgrade evaluation		QA/QC, rubblization and crack and seat	performance monitoring projects
NC	overlay designs, recommended repairs to existing roadways	weight restrictions for posted roads, evaluation of roadways regarding hauling, overweight permit applications, forensic studies	suitability of roadways for rubblization uniformity of construction activities	
ND	structural analysis/pavement design	seasonal subgrade modulus		
ON			no specific information provided	
PA	deflection and resilient modulus data		location of concrete joints with poor load transfer	
PR	overlay thickness and areas to be removed	overlay thickness and areas to be removed	structural capacity	University and FHWA-SHRP
SC	overlay recommendations, pavement design		forensic analysis for early failure	evaluation of new materials
SD	elastic modulus of each layer, soft spots, overlay design	elastic modulus of each layer, soft spots	elastic modulus of each layer, soft spots, road limits	
TN	raw data - computed results in the future			
TX	procedure/analysis/collection support	analysis/collection support	analysis/collection support	Universities - analysis/collection support
UT	all groups get an annual report for pavement condition with FWD test results, modulus, summaries, years to fatigue failure, pavement design project level or special requests to get the test results and five day temperatures			
VA	existing structural condition for use in AASHTO pavement design		identification of weak areas	research - information for specialized projects
VT	structural design			pavement design committee, deflection data
WA	overlay thickness using mechanistic-empirical overlay design procedure developed by WSDOT and the University of Washington		existing pavement strength and determine if pavement removal is necessary	
WV	resilient modulus values			
WI	load transfer, structural strengths	load transfer, structural strength	load transfer structural strength	



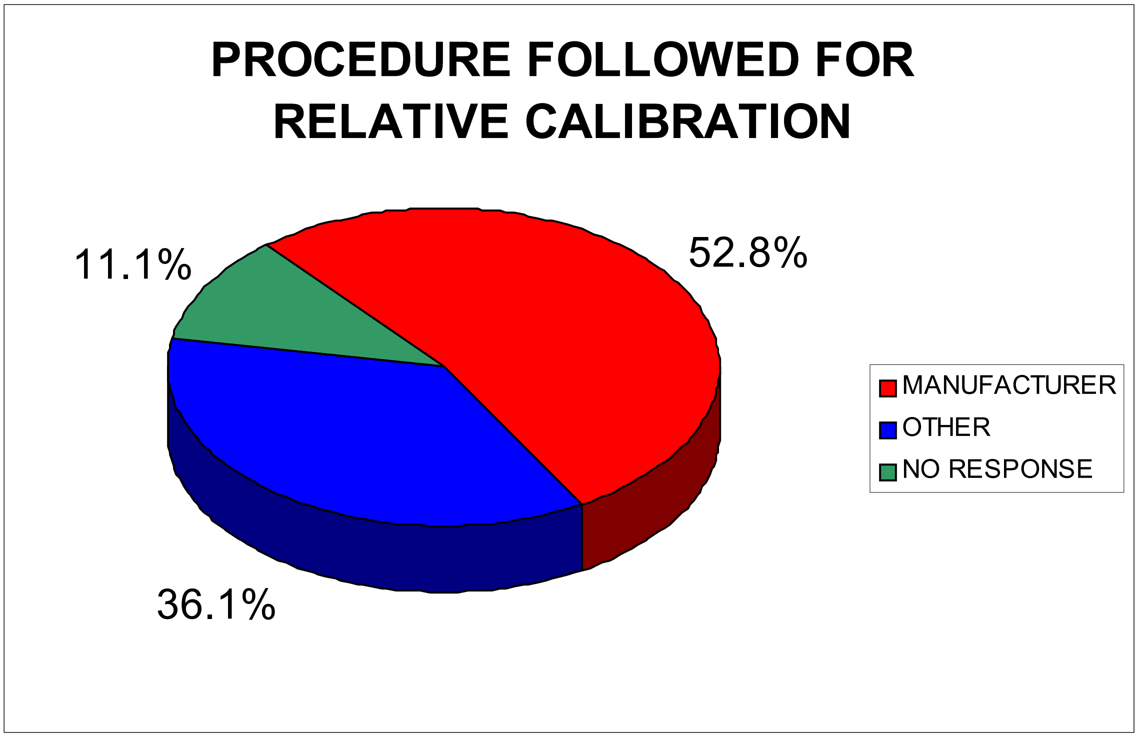
STATES WITH QUALITY ASSURANCE/QUALITY CONTROL PLANS	
AZ	monthly calibration and fixed concrete test pad; generally at annual SHRP center calibration; data collection and import programs of anomalous readings
FL	monthly and annual calibrations; field and office checks; standard testing procedure and project specific instructions
ID	calibration procedures outlined in Operator's manual; calibrated at the Nevada center annually; SHRP quality software, but data quality is checked by the Operator and Pavement Design Eng. Written plans not available
IN	SHRP FWD Calibration Protocol for reference and relative calibration; INDOT has its own calibration center
MD	no information provided
MN	no information provided
NV	detailed set of instructions applicable to every project plus project specific information
SD	SHRP
TX	LTPP calibration protocol
VA	document still in development and not ready for release outside of the agency


FIELD CREW PER FWD UNIT
5%
22%
16%
1
2
VARIES
NO RESPONSE

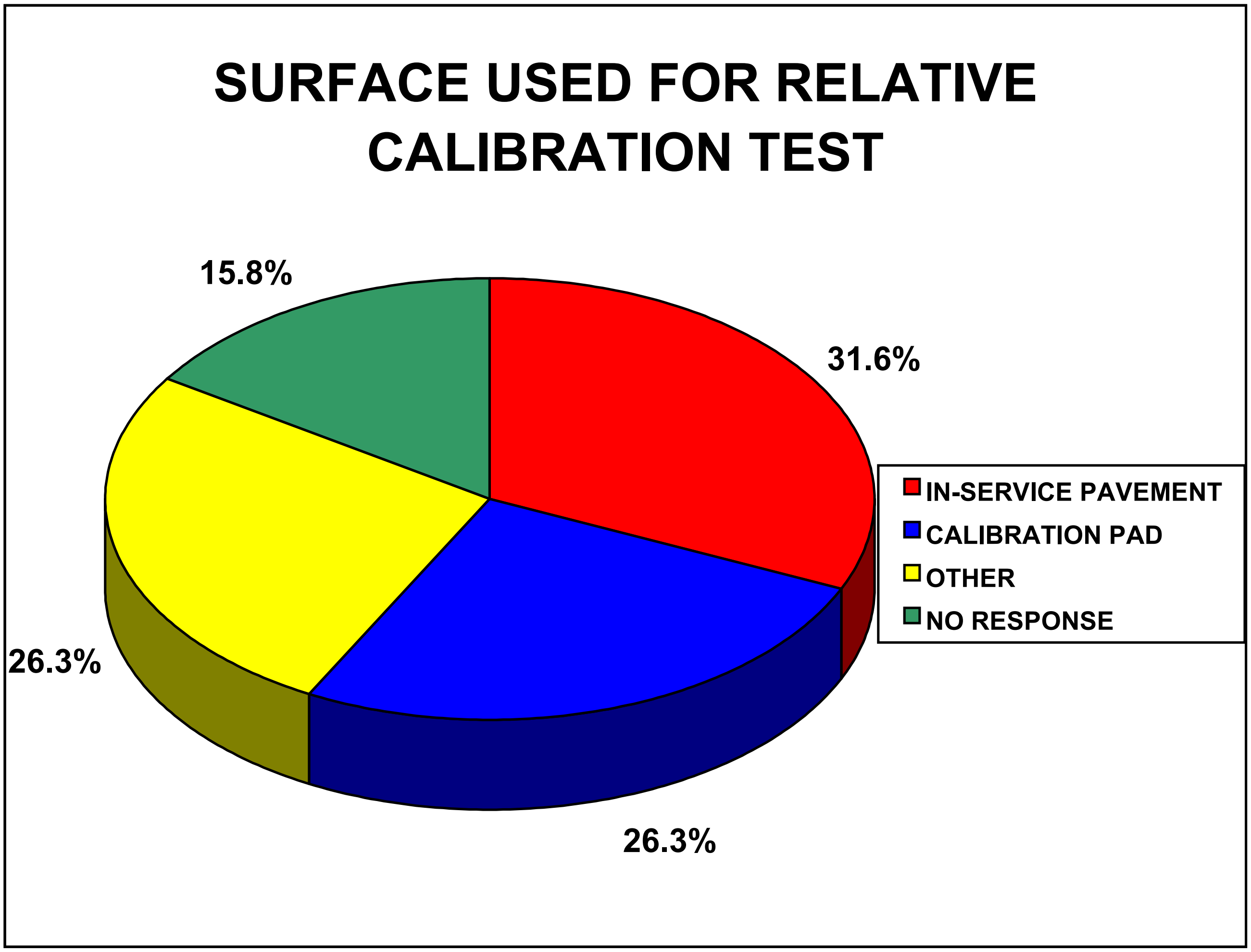




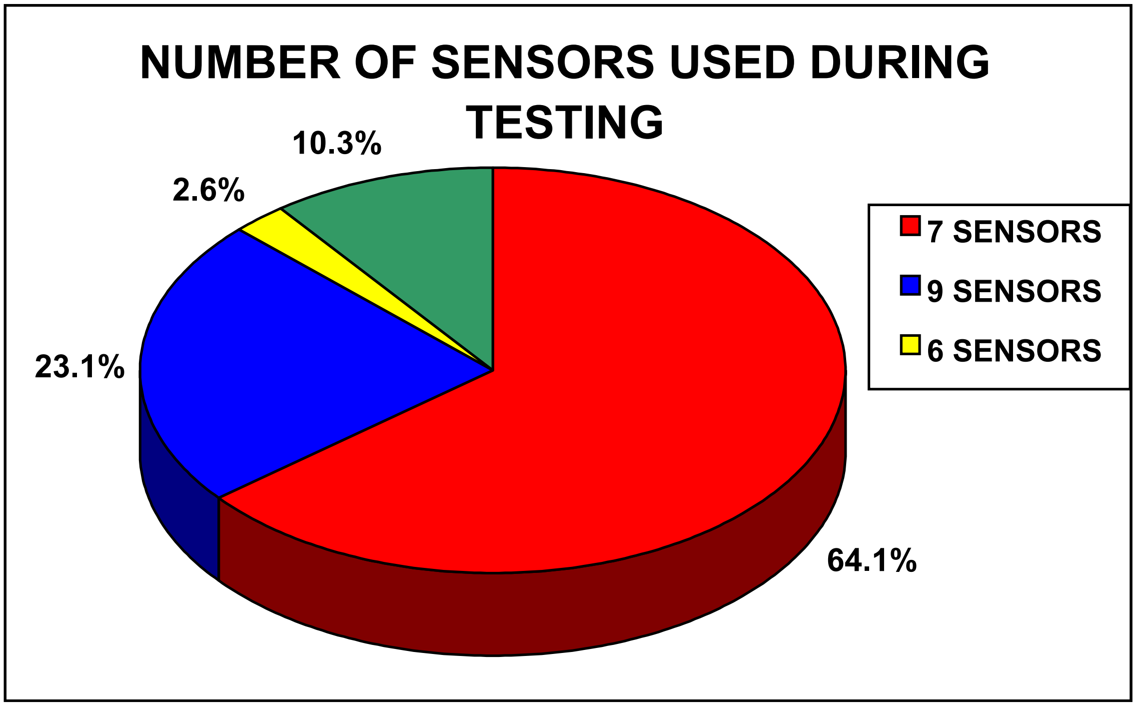
NOTE: *Reference Calibration is the calibration of the FWD unit to known reference standards.*
Relative Calibration is the comparison of FWD deflection sensors to one another.



MANUFACTURER		OTHER		NO RESPONSE
AZ	MS	ID	SHRP Relative Calibration program FWDCAL	
BC(N)	MO	IN	SHRP Calibration procedure	
BC(S)	NC	KS	SHRP/LTPP FWD Calibration Protocol	
FL	ND	MN	SHRP, MN is Central Region Calibration Center	
IL	SC	MI	only performed relative calibration at SHRP Calibration Center at PennDOT	
IA	TN	MT	same procedure as SHRP Center in Reno	
KY	UT	NV	LTPP	
ME	VT	NY	SHRP	
MD	WV	PA	SHRP Protocols	
	WI	PR	SHRP Protocols	
		SD	SHRP Calibration Center at MN DOT	
		VA	SHRP Calibration Procedure	
		WA	LTPP calibration procedures	
19		**13**		**4**

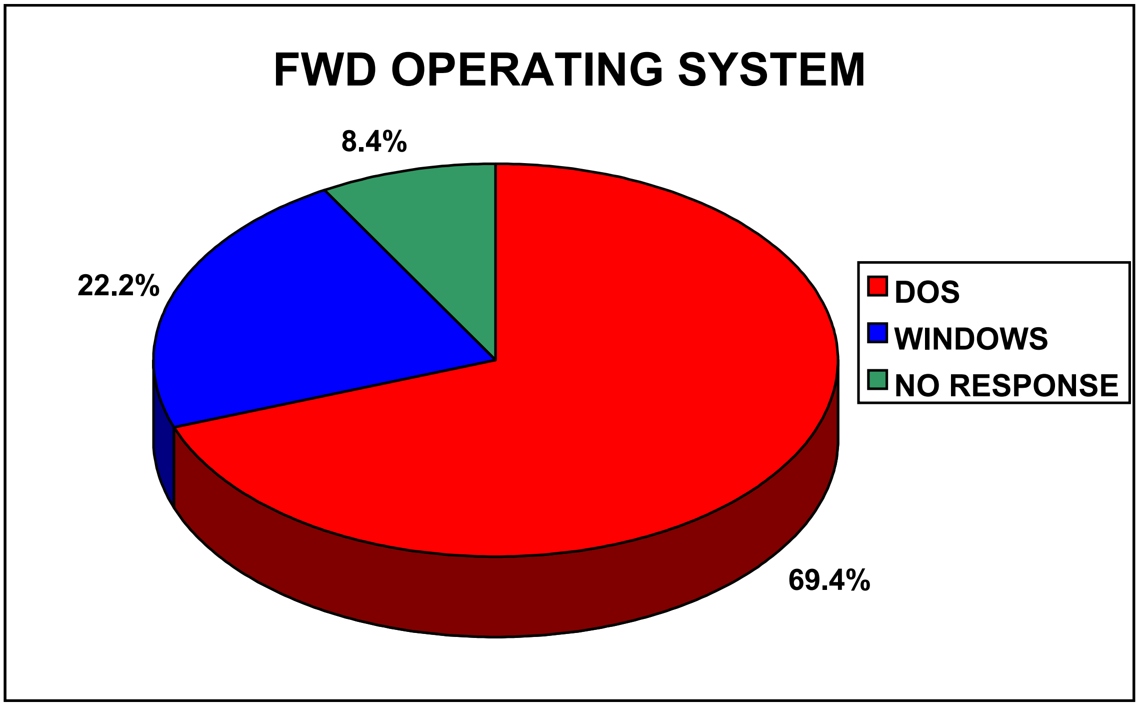


IN-SERVICE PAVEMENT	CALIBRATION PAD	OTHER		NO RESPONSE
BC(S)	AZ	BC(N)	parking lot (AC)	
ID	FL	KS	parking lot (weak asphalt pavement)	
IL	IN	ME	concrete entrance pad to garage	
KY	IA	MI	PennDOT SHRP Calibration Center	
MD	MN	NV	anywhere minimum requirements can be met	
MS	MT	NC	DOT facility lot	
MO	PA	PR	isolated flexible pavement	
MY	PR	SC	shop floor	
ND	SD	VA	garage floor concrete slab	
TN	WV	VT	concrete floor	
VA				
WA				
12	**10**	**10**		**6**



7 SENSORS		9 SENSORS	6 SENSORS	NO RESPONSE
AZ	NV	BC(N)	WA (6)	
FL	NC	BC(S)		
GA	PR	IN		
ID	SC	IA		
IL	SD	MN		
IN	TN	MO		
KS	TX	NY		
KY	UT	VA		
MD	VT			
ME	WA			
MI	WV			
MS	WI			
MT				
25		**8**	**1**	**4**

NOTE: Some agencies have more than one FWD with different numbers of sensors



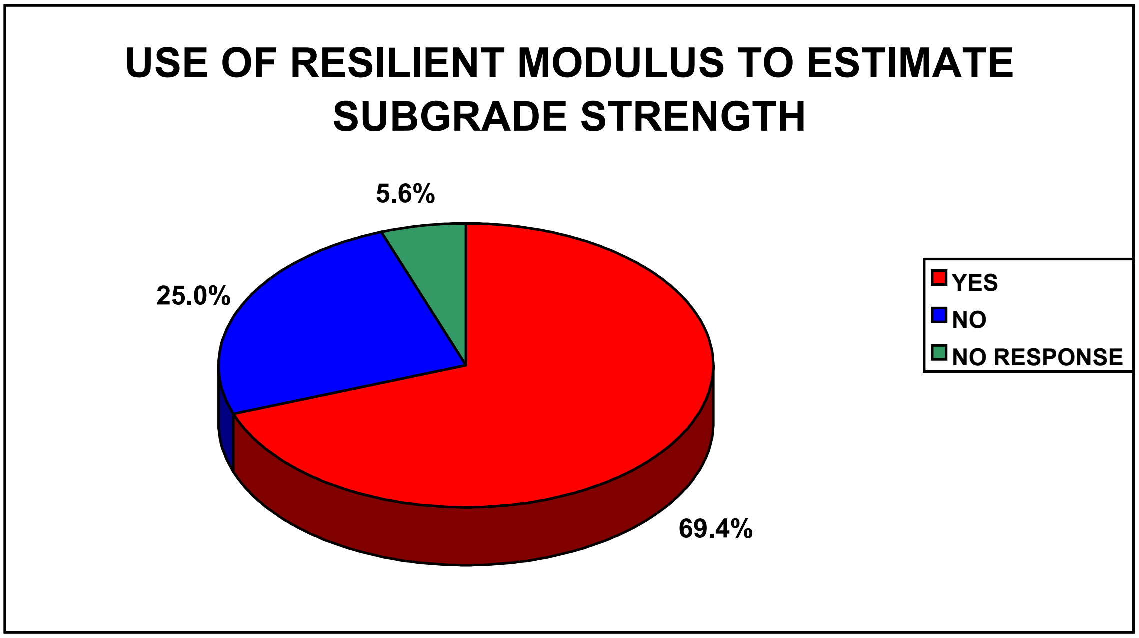
DOS		WINDOWS	NO RESPONSE
AZ	NC	BC(S) (Version 3.1)	
BC(N)	PA	GA (Windows 98)	
FL	PR	IN	
ID	SC	KY (Windows 98)	
IL	TN	MO (WindowsNT 4.0)	
KS	TX	MT (Dynatest 3.1 for edition 25 software)	
ME	UT	ND	
MD	VA	SD (Windows 98)	
MN	VT		
MI	WA		
MS	WV		
NV	WI		
NY			
25		8	3

TABLE 2 FWD Loading Sequence And Sensor Sacing

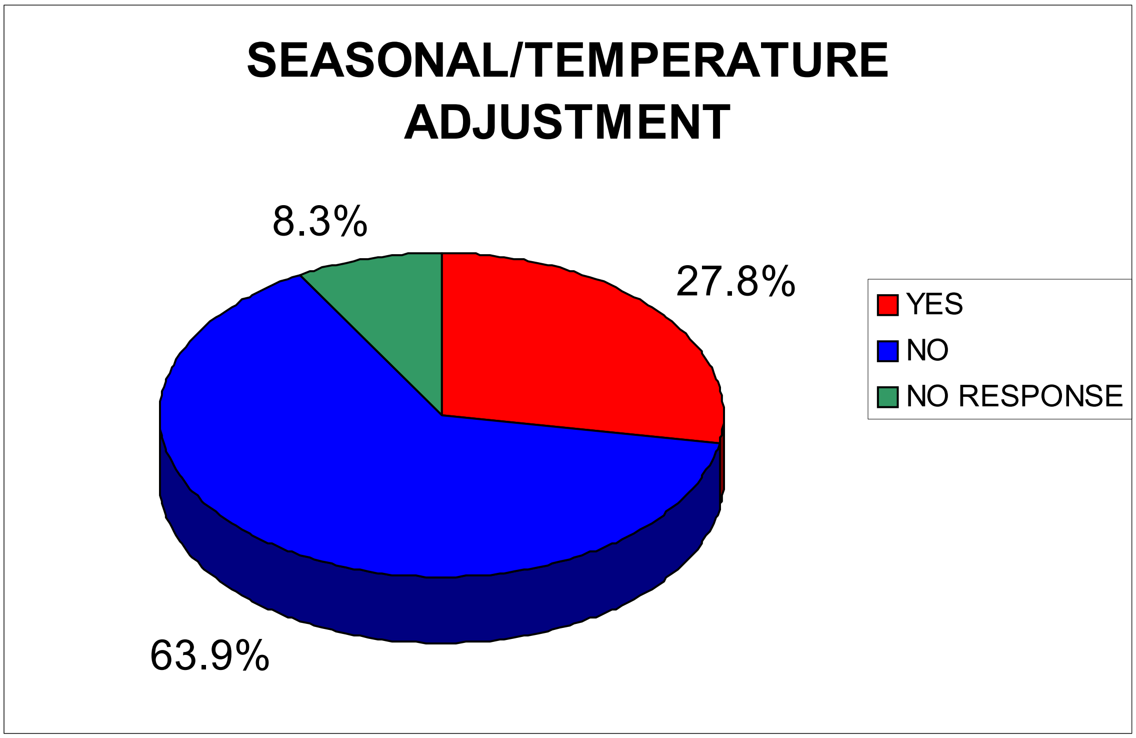
FWD OPERATION											
		TYPICAL SENSOR SPACING (in/mm)									
AGENCY	LOADING SEQUENCE AND MAGNITUDE	AGENCY	D0	D1	D2	D3	D4	D5	D6	D7	D8
AZ	7 repetitions of 5 drops each at 12 kip	AZ	0	12	24	36	48	60	72		
BC(N)		BC	0	200	300	450	600	900	1200	1500	1800
BC(S)	3 seating loads @13 kip; 5 replicate loads @13 kip	BC									
FL	1 seating load @ 9 kip; 2 replicate loads @ 9 kip	FL	0	8	12	18	24	36	60		
GA		GA									
ID	5 drops per set, 7 sets, load level to develop 20 mil deflection	ID	0	8	12	18	24	36	48	60	72
IL	replicate loads @ 9 kip	IL	0	12	24	36	-12	12R	12L		
IN		IN	0	8	12	18	24	36	48	60	72
IA	not determined	IA	0	8	12	18	24	36	48	60	
KS	2 seating loads @ 6 kip; 5 replicate loads @14 kip	KS	0	8	12	18	24	36	60		
KY	X seating loads @15 kip; 4 replicate loads @15 kip	KY	0	8	12	18	24	36	60		
ME	2 seating loads @14 kip; 5 replicate loads @14 kip	ME	0	12	18	24	36	48	60		
MD	2 drops at each load level	MD	0	8	12	24	36	48	60		
MN		MN	0	8	12	18	24	36	48	60	72
MI		MI	0	12	12	8	12	18	24	36	60
MS	2 seating loads @ 16 kip; 5 replicate loads @ 16 kip	MS	0	12	24	36	48	60	72		
MO	2 seating loads @ 9000; 5 replicate loads @ 9000	MO	0	8	12	18	24	36	48	60	-12
MT	35 replicate loads @ 16 kip;	MT	0	8	12	18	24	36	48		
NV	1 seating load w/3 replicate loads @t 11 kips or 1 seating load w/4 drops from heights 1, 2, 3, 4	NV	0	12	24	36	48	60	72		
NJ	to be determined	NJ									
NY	3 seating loads @ 16 kip; 5 replicate loads @ 16 kip	NY	0	8	12	18	24	36	48	60	72
NC	1 seating load @ 9 kip; 3 replicate loads @ 9 kip	NC	0	8	12	18	24	36	48	60	
ND	3 seating loads @ 12 kip; 5 replicate loads @12-16 kip	ND	0	8	12	18	24	30	36	48	60

TABLE 2 FWD Loading Sequence And Sensor Sacing

FWD OPERATION													
			TYPICAL SENSOR SPACING (in/mm)										
AGENCY	LOADING SEQUENCE AND MAGNITUDE	AGENCY	D0	D1	D2	D3	D4	D5	D6	D7	D8
ON		ON									
PA	2 seating loads @ 12 kip; 5 replicate loads @12 kip	PA	0	12	24	36	48	60			
PR	4 seating loads @ 6-16 kip; 1 replicate load @ 9 kip	PR	0	7.87	11.81	17.72	23.62	35.43	47.24	59.06	70.87
SC	2 seating loads @ 6 kip; 5 replicate loads @16 kip	SC	0	200	300	600	900	1350	1800		
SD	1 seating load @ 6 kip; 3 replicate loads @ 9, 12, 14 kip	SD	0	8	12	18	24	36	48		
TN		TN	0	12	24	36	48	60	72		
TX		TX	0	12	24	36	48	60	72		
UT		UT	0	12	24	36	48	60	72		
VA	load level to produce a minimum 16 mils deflection	VA	0	8	12	18	24	36	48	60	72
VT	2 seating loads (1-2 mils); replicate loads (20-40 mils)	VT	0	12	24	30	36	42	48	60	72
WA	2 seating loads @ 8 kip; loading sequence of 8, 6, 4.5, and 3 kip	WA	0	8	12	24	36	48			
				-12	8	12	24	36	48		
WV	X replicate loads @12 kip	WV	0	8	12	18	24	36	48	60	72
WI	1 seating load @ 4.5 kip; 3 replicate loads @ 12.5 kip	WI	0		12	18	24	36	48	60	



STATES AND PROCEDURES USED	
BC(N)	ELMOD Design
BC(S)	ELMOD 4
FL	modified AASHTO Guide
ID	backcalculation
IL	procedure developed by the University of Illinois
IN	no information provided
KS	AASHTO backcalculation procedure
ME	Darwin 3.01, using computed Mr for design purposes
MD	AASHTO Pavement Design Guide Protocol and other backcalculation analysis tools
MN	transitioning from R-value to Mr, EVERCALC and ELMOD and modified laboratory LTPP P-46 protocol
MI	AASHTO Pavement Design
MT	new AASHTO Darwin
NV	no information provided
NY	no information provided
ND	no information provided
ON	backcalculation
PA	AASHTO 1993 Guide
PR	no information provided
SC	no information provided
SD	estimate resilient modulus base on the liquid limit of the soils
UT	AASHTO, Evercalc, CBR correlation
VA	backcalculation according to 1993 AASHTO
VT	Darwin
WA	procedure developed in-house and software developed to read data*
WV	no information provided
WI	standard AASHTO procedures
	* Software can be downloaded at http://www.wsdot.wa.gov/fossc/mats/pavement/fwd.htm



STATES AND ADJUSTMENT FACTORS USED	
BC(N)	Benkelman Beam adjustment factor until a database of seasonal FWD data has been built
BC(S)	no information provided
ID	factors are location dependant depending on freezing of subgrade and spring thaw or on increased winter and spring moisture
IN	no information provided
MN	use temperature to normalize pavement surface deflections
KY	no information provided
NV	no information provided
VT	30% reduction
WA	description in users manual already mentioned

FINDINGS

Following are the general findings on the current practices by the surveyed agencies in three FWD program areas.

FWD Program Management

- Twenty-nine agencies (81%) manage the field-testing in-house, while the other 7 agencies outsource the work.
- Twenty-five agencies (70%) own and operate Dynatest units, four agencies (11%) own and operate JILS units, three agencies (8%) own and operate KUWAB units, and three agencies (8%) own and operate a combination of Dynatest, KUWAB, and/or Jils units.
- The average use of the FWD according to program areas is 63% for structural capacity evaluation, 18% for research, 15 % for pavement investigation, and 4% for other pavement evaluation activities.
- Twenty-eight agencies (78%) use the FWD at the project level, while seven agencies (19%) use it at both project and network levels.
- Fourteen agencies (37%) use a total of two full time staff per FWD unit.
- Twenty-two agencies (61%) test between 0 to 500 roadway lane miles annually.
- The average annual FWD operating budget varies among agencies depending on the number of projects, project length, and individual costs involved.
- In addition to testing State highways, 14 agencies (39%) use the FWD to test city streets, four agencies (11%) test airport runways, and six agencies (17%) test some other type of facilities.
- Nineteen agencies (53%) use their maintenance units and/or own staff to provide maintenance of traffic during testing.
- Thirty-three agencies (92%) provide FWD testing services to the Design group.
- Most of the agencies require an average of one to two weeks lead- time for FWD testing.
- Most of the agencies require one to two weeks turn around time for the test results.

FWD Operation

- Seventy two percent of agencies have a Quality Control/Quality Assurance plan in effect.
- Twenty-one agencies (57 %) typically use one crewmember per FWD unit.
- Twenty-six agencies (72 %) have an annual reference calibration performed on their FWD unit(s).
- Over 69% perform a monthly relative calibration on their FWD unit(s).
- About 53% follow the manufacturer's relative calibration procedure while 36 % follow some other procedures.
- Over 31% use in-service pavements to perform a relative calibration.
- Sixty four percent use seven sensors when testing for a typical pavement rehabilitation project.
- Nearly 70 % of the FWD units owned by these agencies operate under the DOS environment.

Pavement Design Parameters

- Close to 70% of the agencies use the Resilient Modulus value to estimate subgrade strength.

Only 28% of the agencies use a seasonal and/or temperature adjustment factor(s) for determining the effective subgrade modulus.

LIST OF TABLES

LIST OF FIGURES