BECHTEL POWER CORPORATION
SUPPLIER DOCUMENT REVIEW
CLASSIFICATION & STATUS

☐ Nuclear Safety Related ☐ Augmented Quality ☒ Non-Safety-Related

STATUS CODE:
1 ☒ Work may proceed
1C ☐ Work may proceed. Editorial comments need only be incorporated if revised for other purposes.
2 ☐ Revise and resubmit. Work may proceed subject to incorporation of changes indicated
3 ☐ Rejected. Revise and Resubmit.
4 ☐ Review not required. Work may proceed.

Permission to proceed does not constitue acceptance or approval of design details, calculations, analysis, test methods, or materials developed or selected by the Supplier and does not relieve the Supplier from full compliance with contractural obligations.

Reviewed by	Arch	Civil	CS	Elect	Mech	MET	PD	Constr	Startup	STE
	N/A	RL	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Status By: Ritchie Date: 6/13/12

Tests to Determine the Behavior of #11 Bars with Lap Splices

Bowen Laboratory
Purdue University
Spring 2012

Test Procedure

1. Fabrication

1.1 Formwork

The formwork shall be made using non-absorbent plywood. Its interior shall be caulked to prevent water leakage and it shall be covered with a thin layer of oil before casting. The dimensions of the formwork shall be checked and recorded using Form 1.

1.2 Reinforcement Cages

The steel reinforcement cages shall be built following the drawings attached. Reinforcing bars shall be supported by steel chairs placed away from lap splices. To ensure alignment, the bars shall be tied to chairs and to one another using gage-16 steel wire. The location of the reinforcement shall be recorded using Form 1. The locations of wire ties and rebar markings shall be recorded using Form 2.

Tolerances (within the test region) are:

3/16" for horizontal cover and horizontal spacing measured to the surface of the bar (excluding ribs)
1/4" for vertical distances shown in Form 1

1.3 Casting

Fresh concrete properties to be measured include:

Unit Weight
Slump
Air Content

These measurements shall be made following the Specifications and recorded using Form 3.

Slump shall be measured before any other activity related to casting takes place to make sure that the delivered mix has satisfactory workability. The mixing truck shall deliver a ticket with the batched mix weights. These weights shall be examined to corroborate that the delivered mix has the specified proportions. Concrete shall not be accepted if it arrives more than 45 min. after leaving the batching plant. No water shall be added to the mix after the truck leaves the plant.

Specimens and cylinders shall be cast and vibrated in two lifts following the Specifications. The vibrators to be used shall have the following cross-sectional dimensions:

For cylinders:	3/4" - 7/8"
For Larger Specimens:	1-3/4"

Their frequencies shall be between 50 and 200 Hz.

Excess concrete shall be removed off the formwork. The exposed surfaces of the specimens shall be finished using cast magnesium floats. Lifting inserts shall be inserted in the fresh concrete as soon as the finishing is completed.

Each test beam shall be cast using concrete from a single mixing truck. A complete set of concrete samples (cylinders) shall be obtained from each truck. Test beams and samples shall be marked with a number referring to the truck from which they were cast and the date of casting. In each casting day, trucks shall be numbered sequentially starting at 1. The number assigned to a truck shall be written clearly on the mix ticket describing the mix proportions for the batch. Test beams shall be cast and tested oriented in the North-South axis of the laboratory. During finishing, the north end of each beam shall be marked with the letter N.

These activities shall be documented using Form 3

1.4 Curing

As soon as casting is completed all specimens shall be covered with impermeable sheets. When the concrete surface sets, wet burlap shall be inserted between these sheets and the exposed concrete. All formwork and molds shall be struck no later than three days after the cast.

All exposed concrete surfaces shall be covered by wet burlap and impermeable sheets for a total of at least seven days after casting.

Burlap shall be doused with water at least every other day during the curing period.

Curing activities shall be logged using Form 4.

Test cylinders shall be stored and cured next to the test specimens and under similar conditions of temperature and humidity.

The variation of concrete strength with time shall be monitored as specified in the Specifications. The results of cylinder tests shall be recorded using Form 5.

2. Calibration

Three types of measurements will be made: displacement, force, air content.

The apparatuses to be used to calibrate sensors to measure these quantities are:

Displacement Sensors: INSTRON Universal Testing Machine (S.N.:)
Load Sensors: INSTRON Universal Testing Machine (S.N.:)
Air Content: Calibrated Cylinder (S.N.)

Load and displacement sensors will be calibrated following steps listed below:

1) Connect the sensor to the data-acquisition system that is going to be used in the test
2) Set and record the excitation voltage to the maximum possible value (not exceeding the maxima specified for the data-acquisition system and the sensor)
3) Set the data-acquisition equipment to record voltage
4) Set the gain of the data-acquisition system to the first available level lower than the ratio of the maximum range of the system to the maximum expected output from the sensor.
5) Mount the sensor on the universal testing machine
6) Apply a series of known displacement or force increments to the sensor ranging between 10% and 90% of the rated capacity of the sensor
7) Record the voltage read on the data-acquisition system at each known displacement or force increment
8) Create a plot of change in output voltage vs. change in force or displacement
9) Fit a line to the plot from 7) using "least squares"
10) Record the slope of the line from 8) (sensor sensitivity)
11) Label the cable used in the calibration with the serial number of the sensor

Sensors shall be calibrated before the first test and after the final test.

The apparatus used to measure air content of the fresh concrete shall be calibrated following the procedure described in ASTM standard 231. Form 6B shall be used to document the calibration.

All calibrations shall be performed by at least two persons: one leading each step and the other checking the work of the first independently. A log of each calibration shall be made using Form 6 and it shall include an estimate of the accuracy of the sensor.

Sensors for which the sensitivity obtained in 9) above deviates by more than 10% from the nominal sensitivity (as reported by the manufacturer) shall not be used in any of the tests.

3. Setup

Each test beam shall be placed on two roller supports as described in the attached proposal. The final location of the supports shall be measured ~~(~~to the nearest 1/16 in.~~)~~ with maximum deviation of ¼ in and reported using Form 7. As-built external dimensions of each test beam shall be recorded using the same form. The maximum deviation from nominal dimensions in the test region shall be ¼ in.

The test beam shall be placed with the reinforcement facing up as shown in the attached proposal.

The shear spans shall be reinforced with external stirrups (pairs of 5/8-in threaded rods) installed at a spacing not exceeding 12 in. The locations of the stirrups shall be measured. The measurements shall be recorded using Form 7.

The loading rigs (consisting of a loading tube, two hydraulic rams, two threaded rods, plates and nuts, and one load cell per rig) shall be placed on the test specimen and connected to "the strong floor" of the laboratory (without applying load to the specimen other than the weight of the rigs) as described in the attached proposal. The rams in each rig shall be connected to a single manifold and pump using 10,000-psi hydraulic hoses. All hoses and other hydraulic hardware shall be inspected visually and replaced –if defective- before testing.

4. Instrumentation

Displacement sensors shall be installed at midspan, at each support, and at each load point. They shall be secured to the strong floor of the laboratory directly below the point where displacement is to be measured.

All sensors (displacement and force) shall be connected to the data acquisition system using the same cables used during calibration. The excitation voltage and gain shall also be set to the value used in calibration. The data acquisition system shall be set to record voltage changes caused by loading. Before applying load with the hydraulic rams, all sensors shall be set to read a voltage value between 10% and 90% of the voltage output of the sensor at its rated capacity. These voltages shall be referred to as the "zero offsets" of the sensors. If a sensor is set to have an initial

voltage exceeding 20% of its output at rated capacity, the sign of the initial "zero offset" shall be opposite to the sign of the expected change in its signal.

Set the data acquisition system to scan all sensors and save at least one record per sensor every 1 sec.

Record a file of "zero offsets" capturing at least 10 min. of data before any load is applied with the hydraulic system.

Means of initial voltages for all sensors (mean "zero offsets"), sensor serial numbers, the most recent sensitivity constants, excitation voltages, and the channels of the data-acquisition system used for each sensor shall be recorded using Form 8. The pairing of channels and sensors shall be checked by a second person working independently from the person making the initial connections.

Infrared targets to be used to measure displacements as described in the attached proposal shall be glued to one face of the test beam using epoxy adhesive. The numbering sequence of these targets shall be recorded using Form 9.

Video cameras (one for long-time lapse video and one for high-speed video) will be positioned to capture the response of the mid third of each specimen. To the extent possible, the location of the cameras shall be the same in all tests.

5. Testing

The following actions shall take place during each test:

At the end of each loading increment:

Mark Cracks: all visible cracks shall be marked using black permanent markers. Cracks shall be marked by drawing lines parallel to them and with an offset of approximately 0.25 in.

Measure Crack Widths: Crack widths shall be measured using crack comparators or graduated handheld microscopes.

Measure coordinates of infrared coordinates: A set of coordinates shall be obtained using an OptoTrack System 600 Pro. A set of four targets shall be attached to the strong floor. They shall be located at approximately the same distance to the OptoTrack cameras as targets attached to the test beam. Coordinates for these reference targets shall be obtained at each loading increment. They are to be used to monitor the stability of the Optotrack system by computing the variation in the distances between reference targets.

In-Test Data Backup: At every loading increment the data being produced by the data-acquisition system shall be copied to an external hard drive.

Photographs: a set of high-resolution photographs shall be obtained after cracks are marked at each loading increment. The photographs shall includes views of both elevations of the test beam and the top concrete surface above lap splices.

The following data shall be recorded throughout each test:

Sensor readings: to be recorded on a hard drive in volts. Conversion to engineering units shall be done after the test as follows:

-Subtract zero offsets
-Divide the result by the sensitivity obtained in the most recent calibration

Lapse video photographs: to be obtained every 5 min.

Actions to be taken at failure

Trigger high-speed camera to record breaking away of the concrete cover and relative movement of the bars.

Actions to be taken after test

Generate a record of sensors that may have malfunctioned or been accidentally moved during the test

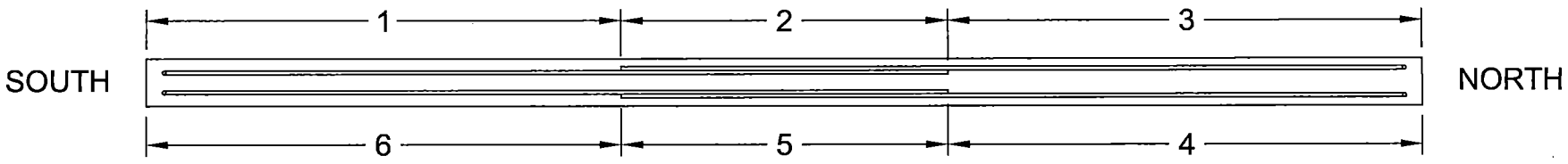
Remove from all files recordings from sensors for which the results of the after-test calibration differ by more than 5% from the before-test calibration.

6. Reporting and Backup

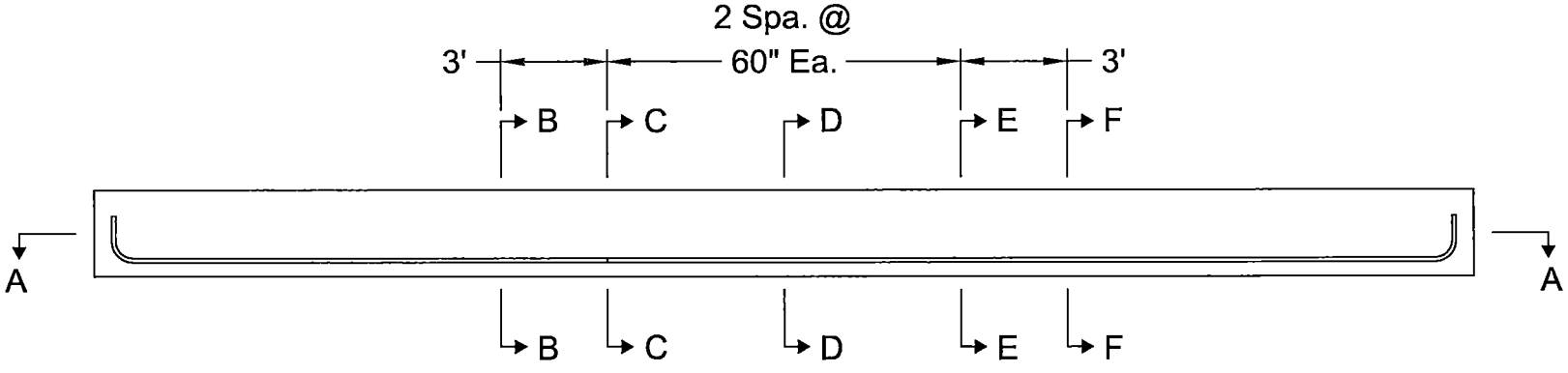
Produce all the captured data in two ways:

By uploading data, photos, and video to a private project at nees.org.
By recording all data, photos, and video on a magnetic hard drive

Reports shall be produced as described in the Specifications.



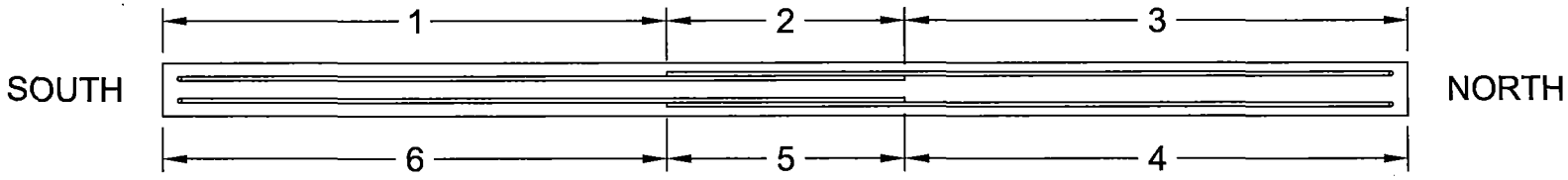
Section A-A



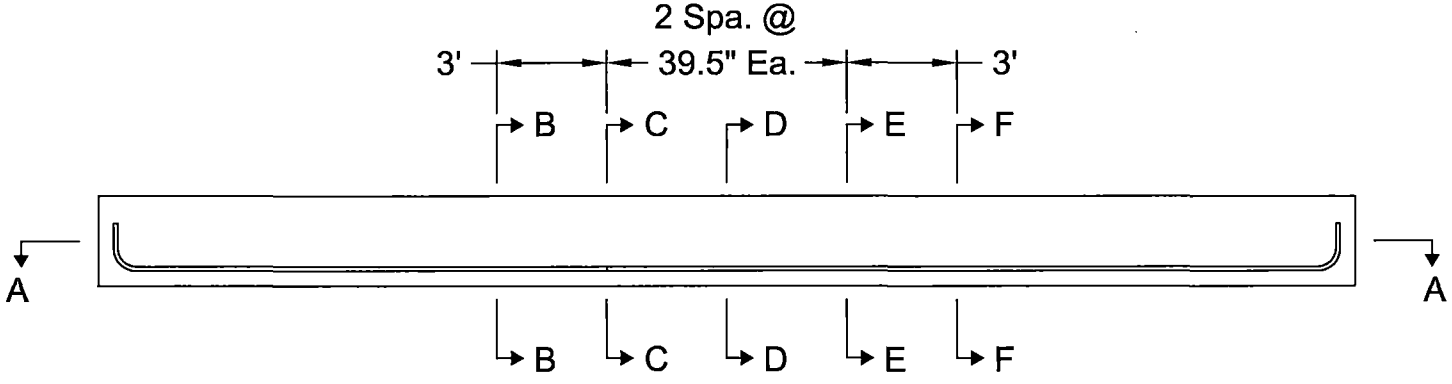
*For section B-B through F-F see Sheet 3 of 3

Series A

BOWEN LABORATORY PURDUE UNIVERSITY	Drawing:	Series A Formwork As-builts	Sheet:	1 of	3
	Project:	Experimental Investigation of Capacity of Lap Splices of No. 11 Reinforcing Bars	Drawn by:	BPR Checked by:	SP
			Date:	04/04/2012	



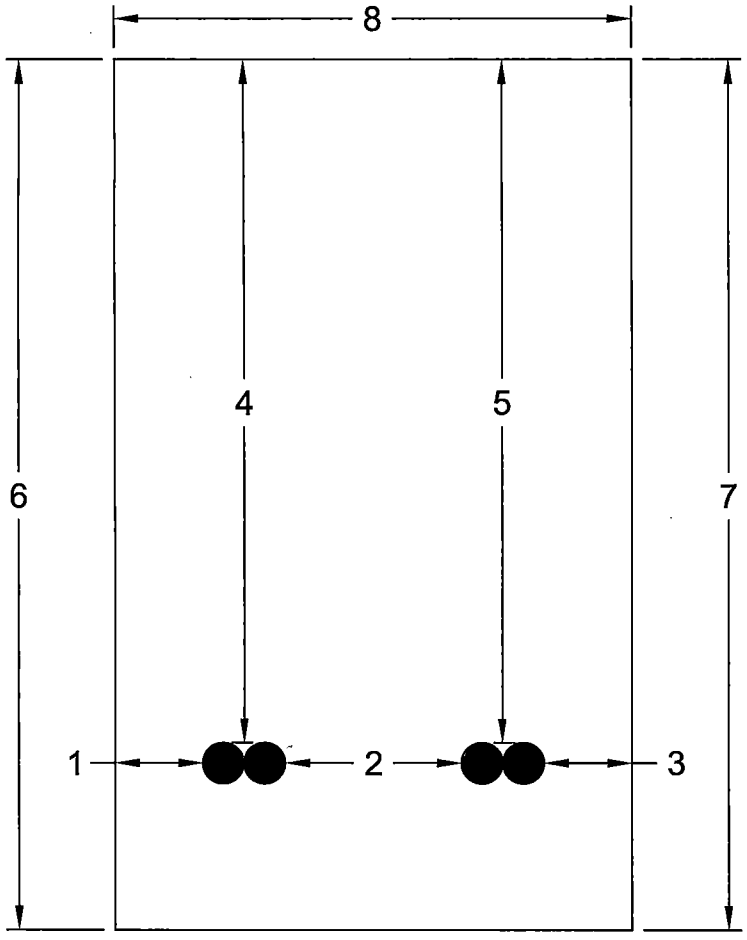
Section A-A



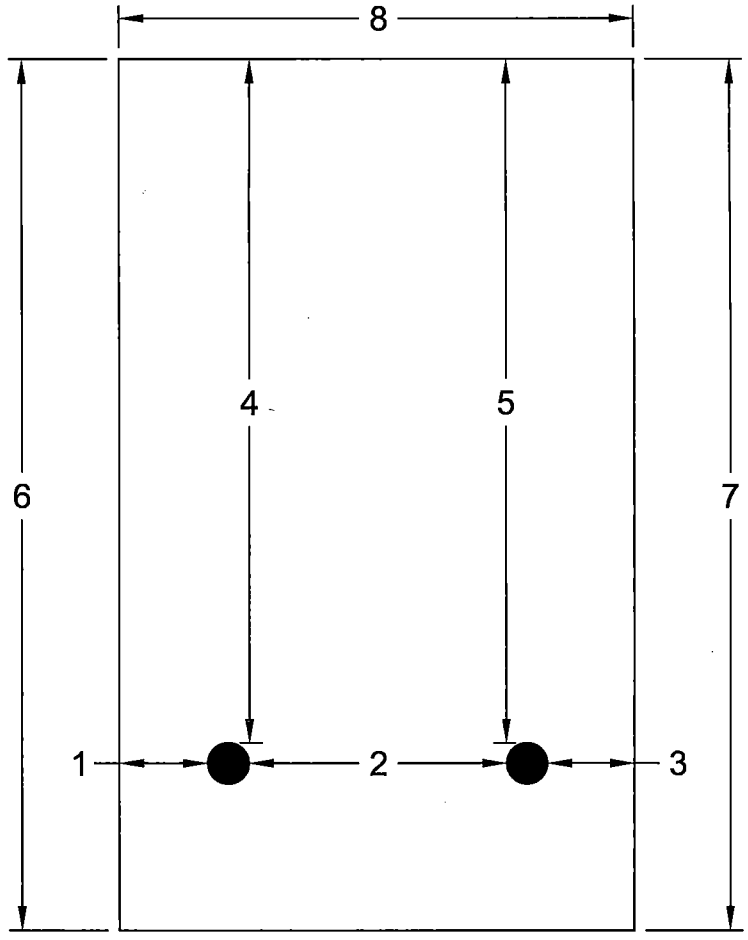
*For section B-B through F-F see Sheet 3 of 3

Series B

BOWEN LABORATORY PURDUE UNIVERSITY	Drawing:	Series B Formwork As-builts	Sheet:	2 of	3
	Project:	Experimental Investigation of Capacity of Lap Splices of No. 11 Reinforcing Bars	Drawn by:	BPR Checked by:	SP
			Date:	04/04/2012	



Section C-C, D-D, & E-E
*Facing North



Section B-B & F-F
*Facing North

BOWEN LABORATORY PURDUE UNIVERSITY	Drawing:	Formwork As-built Sections	Sheet:	3 of 3	
	Project:	Experimental Investigation of Capacity of Lap Splices of No. 11 Reinforcing Bars	Drawn by:	BPR	Checked by: SP
			Date:	04/04/2012	

Form 1

Project: Tests to Determine the Behavior of Spliced #11 Bars

As-built Dimensions v.1 (Rev. 04/04/2012)

Specimen:_____

Section	Formwork As-built Dimensions							
	1	2	3	4	5	6	7	8
A-A								
B-B								
C-C								
D-D								
E-E								
F-F								

Recorded by:	Signature	Date	Time

Checked by:	Signature	Date	Time

Checked by:	Signature	Date	Time

Comments:

*See formwork as-built drawings for dimension locations

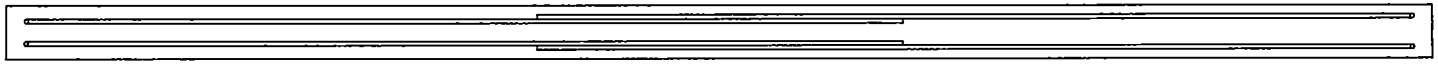
Project: Tests to Determine the Behavior of Spliced #11 Bars

As-built Dimensions v.1 (Rev. 04/04/2012)

Specimen:_____

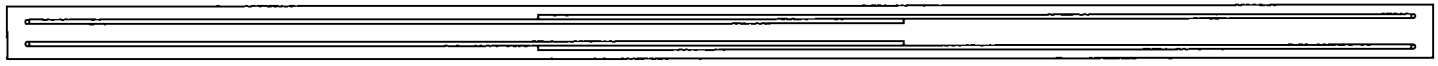
Section	Formwork As-built Dimensions Key - Series A							
	1	2	3	4	5	6	7	8
A-A	14'-6"	10'-0"	14'-6"	14'-6"	10'-0"	14'-6"	N/A	N/A
B-B	4-3/8"	6"	4-3/8"	23-5/8"	23-5/8"	30"	30"	17-5/8"
C-C	3"	6"	3"	23-5/8"	23-5/8"	30"	30"	17-5/8"
D-D	3"	6"	3"	23-5/8"	23-5/8"	30"	30"	17-5/8"
E-E	3"	6"	3"	23-5/8"	23-5/8"	30"	30"	17-5/8"
F-F	3"	8-3/4"	3"	23-5/8"	23-5/8"	30"	30"	17-5/8"
Section	Formwork As-built Dimensions Key - Series B							
	1	2	3	4	5	6	7	8
A-A	13'-10.5"	6'-7"	13'-10.5"	13'-10.5"	6'-7"	13'-10.5"	N/A	N/A
B-B	4-3/8"	6"	4-3/8"	23-5/8"	23-5/8"	30"	30"	17-5/8"
C-C	3"	6"	3"	23-5/8"	23-5/8"	30"	30"	17-5/8"
D-D	3"	6"	3"	23-5/8"	23-5/8"	30"	30"	17-5/8"
E-E	3"	6"	3"	23-5/8"	23-5/8"	30"	30"	17-5/8"
F-F	3"	8-3/4"	3"	23-5/8"	23-5/8"	30"	30"	17-5/8"

Wire Ties



NORTH

Bar Marks



NORTH

BOWEN LABORATORY PURDUE UNIVERSITY	Specimen:					
	Project:	Behavior of Lap Splices of No. 11 Reinforcing Bars	Drawn by:		Checked by:	
			Date:			

Form 3

Project: Tests to Determine the Behavior of Spliced #11 Bars

Casting Documentation v.1 (Rev. 03/30/2012)

Specimen:_____

Sheet 1 of 1

General Information					
Date	Disp Ticket Num	Truck No.	Time on Ticket	Time of Arrival	Temp. in Lab
Measurements made upon arrival of concrete					
Slump (ASTM C143 - 10a)		**Air Content (ASTM C231 - 10)**			
$Time_1$	$Result_1$	$Time_1$	$Result_1$	S/N of Air Meter	
$Time_2$	$Result_2$	$Time_2$	$Result_2$	S/N of Scale	
Unit Weight (ASTM C138 - 10b)					
$Time_1$	Wt. of $Cont._1$	Total $Wt._1$	Wt. of $Conc._1$	$Result_1$ = Wt. of Conc./Vol. of Cont.	
$Time_2$	Wt. of $Cont._2$	Total $Wt._2$	Wt. of $Conc._2$	Result2 = Wt. of Conc./Vol. of Cont.	
Times of actions during and after casting					
Layer 1 placed	Layer 1 vibration complete	Layer 2 placed	Layer 2 vibration complete	Top surface struck off	Truck Departing Lab
Lifting Inserts Placed	Covered with plastic	Plastic removed	Covered with burlap	Burlap doused with water	Covered with plastic
Recorded by		Signature		Date	Time
Checked by		Signature		Date	Time
Checked by		Signature		Date	Time
Comments:					
*The following ASTM standards and specifications will be followed during casting: C172-10, C192-07, C470-09					

Form 4

Project: Tests to Determine the Behavior of Spliced #11 Bars

Curing Documentation v.1 (Rev. 03/30/2012)

Purdue University - Bowen Laboratory

Sheet 1 of 1

General Information		
Specimen(s)	Date	Specimen Age
	Time Beginning	Time Ending
	Temperature inside Lab (deg. F)	

Description of Work Performed

Recorded by	Signature	Date	Time
Checked by	Signature	Date	Time
Checked by	Signature	Date	Time

Comments:

*Test specimens and associated cylinders are to be cured under wet burlap for seven days

Project: Tests to Determine the Behavior of Spliced #11 Bars

Cylinder Compression Tests Documentation v.2 (Rev. 04/01/2012)

Specimen: _____

Specimen	Date	Time of Test	Wet/Dry	Diameter [nearest 0.01 in.]		Length [nearest 0.05 in.]			P_{max} [lb_f]	Fracture Type (1-6)
				1	2	1	2	3		
1										
2										
3										
4										
5										
6										

S/N of Testing Machine:			
Recorded by:	Signature	Date	Time
Checked by:	Signature	Date	Time
Checked by:	Signature	Date	Time

Comments:

*Cylinders to be test per ASTM C-39-12 and C-1231-10a with a loading rate of 60,000lb_f/min at concrete ages of 3, 7, 14, 28 days, and on same day that test of corresponding specimen is conducted. Specimens and caps free of defects unless otherwise noted in comments. Average cylinder diameter and area and unit compressive stress (f'_c) calculated on sheet 2 of 2.

Project: Tests to Determine the Behavior of Spliced #11 Bars

Cylinder Compression Tests Documentation v.2 (Rev. 04/01/2012)

Specimen: _____

Specimen	Date	Age	Time of Test	Wet/Dry	Average Measured Dia. [in.]	Cross-sectional Area [in2]	P_{max} [lb_f]	f'_c [psi]	Fracture Type (1-6)
1	0-Jan		12:00 AM	0	#DIV/0!	#DIV/0!	0	#DIV/0!	0
2	0-Jan		12:00 AM	0	#DIV/0!	#DIV/0!	0	#DIV/0!	0
3	0-Jan		12:00 AM	0	#DIV/0!	#DIV/0!	0	#DIV/0!	0
4									
5									
6									

S/N of Testing Machine:			
Recorded by:	Signature	Date	Time
0		0	0
Checked by:	Signature	Date	Time
0		0	0
Checked by:	Signature	Date	Time

Comments:

*Cylinders to be test per ASTM C-39-12 and C-1231-10a with a loading rate of 60,000lbf/min at concrete ages of 3, 7, 14, 28 days, and on same day that test of corresponding specimen is conducted. Specimens and caps free of defects unless otherwise noted in comments. Recorded data is shown on sheet 1 of 2.

Project: Tests to Determine the Behavior of Spliced #11 Bars

Form 6
Calibration Documentation v.1
(Rev. 04/02/2012)

Bowen Lab - Purdue University
Sheet 1 of 1

Calibration Instrument Name and S.N.:	
Data Acquisition System:	
Gain:	
Excitation Voltage:	
Channel:	
Sensor:	
Sensor S.N.:	

Measurand	Voltage	Measurand	Voltage	Measurand	Voltage

Operator	Signature	Date	Time

Checked by	Signature	Date	Time

Checked by	Signature	Date	Time

Results	Sensitivity	Accuracy

Notes:

Project: Tests to Determine the Behavior of Spliced #11 Bars

Form 6B
Calibration Documentation v.1
(Rev. 04/06/2012)

Bowen Lab - Purdue University
Sheet 1 of 1

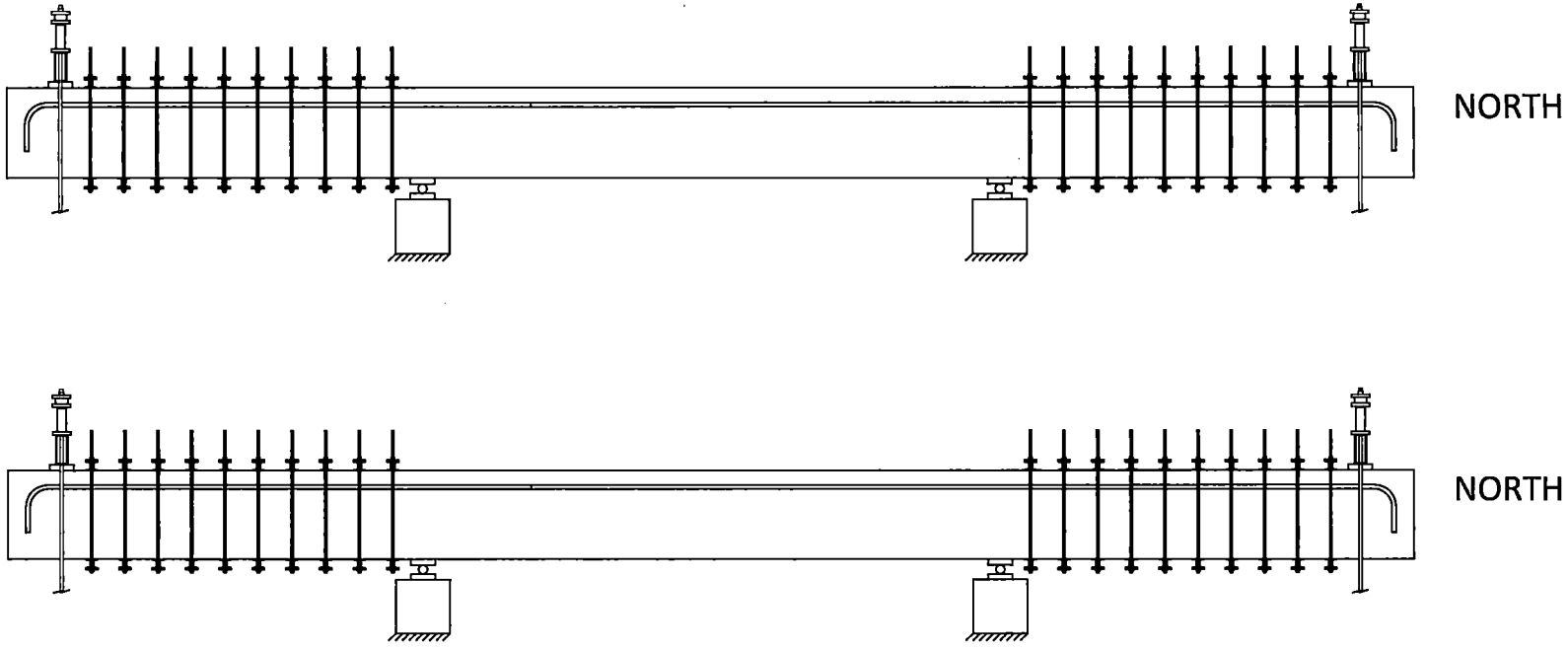
Meter S.N.	
Type of Meter	
Meter Brand Name	
Ambient Temperature	

[redacted]

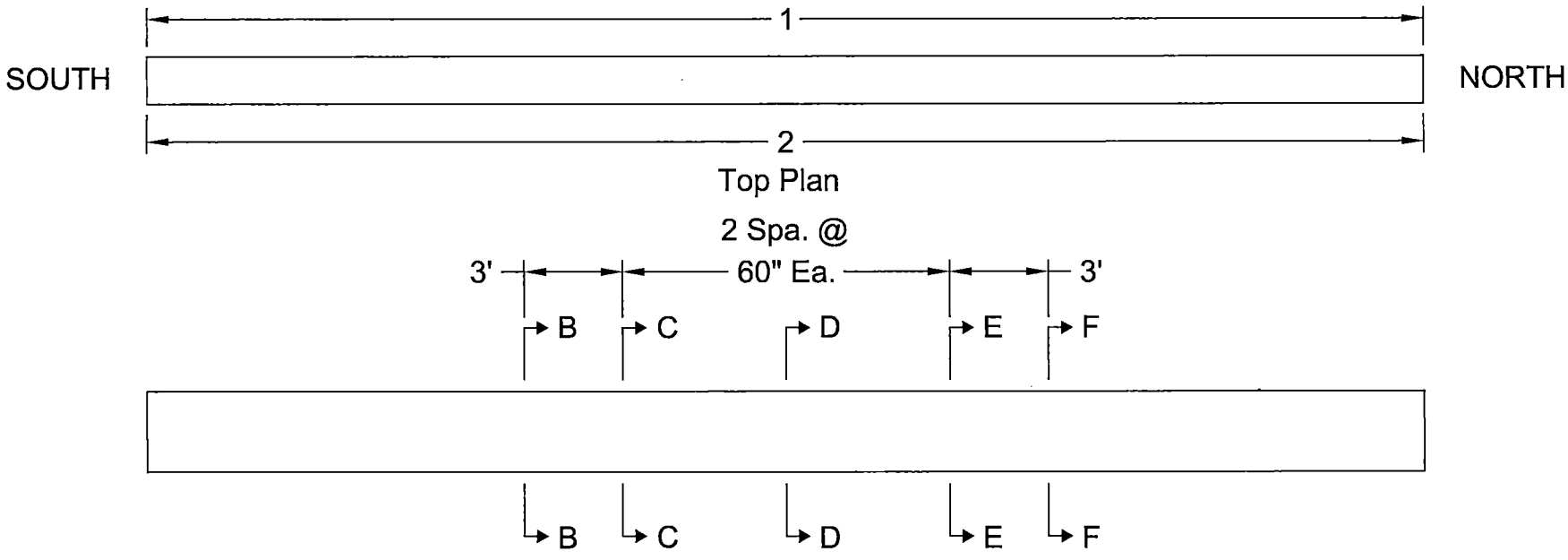
Target Air Content	Measured Air Content

Operator	Signature	Date	Time
Checked by	Signature	Date	Time
Checked by	Signature	Date	Time

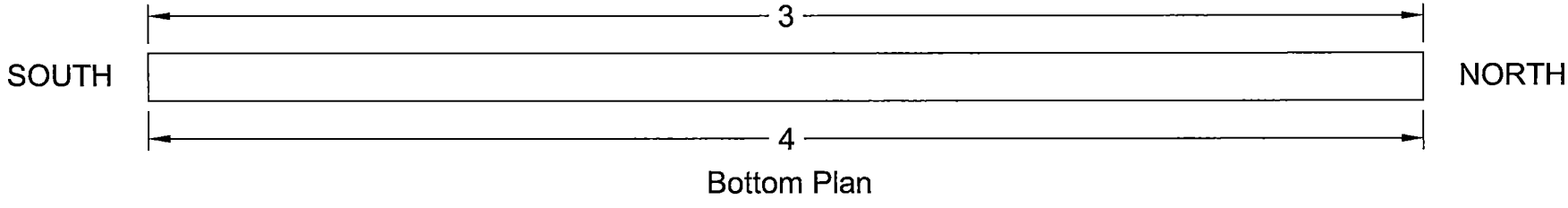
Notes:



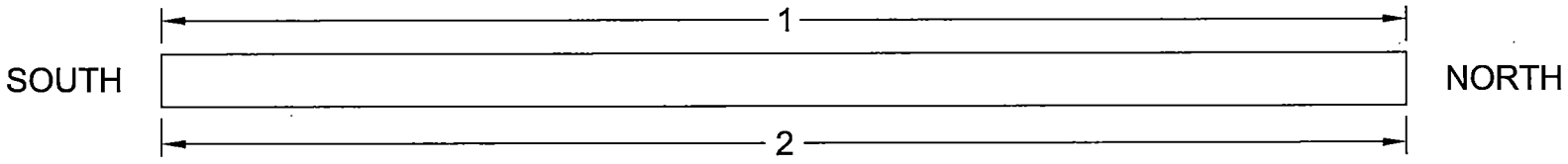
BOWEN LABORATORY PURDUE UNIVERSITY	Specimen	Sheet:	1	of	4
	Behavior of Lap Splices of No. 11 Reinforcing Bars	Drawn by:		Checked by:	
		Date:			



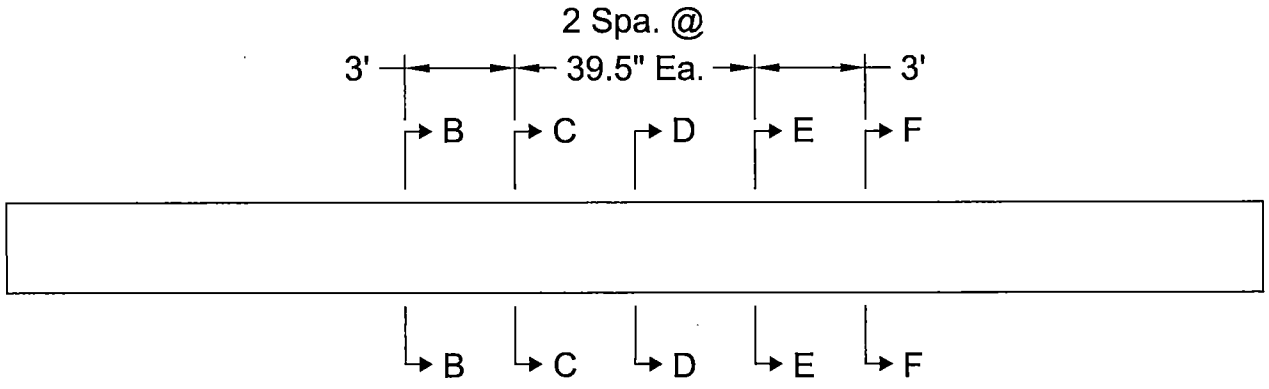
*For section B-B through F-F see Sheet 3 of 3



BOWEN LABORATORY PURDUE UNIVERSITY	Drawing:	Series A Concrete As-builts	Sheet:	2 of 4	
	Project:	Experimental Investigation of Capacity of Lap Splices of No. 11 Reinforcing Bars	Drawn by:	BPR	Checked by: SP
			Date:	04/04/2012	

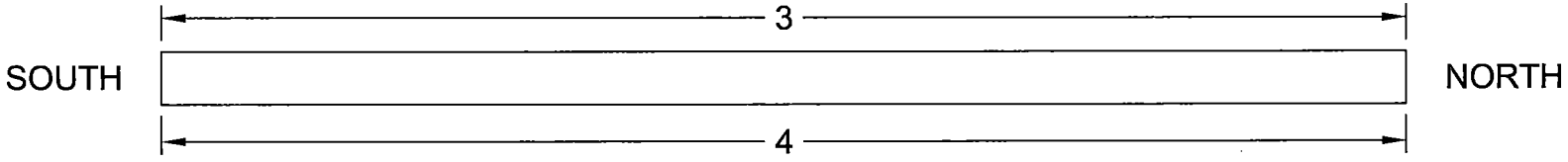


Top Plan



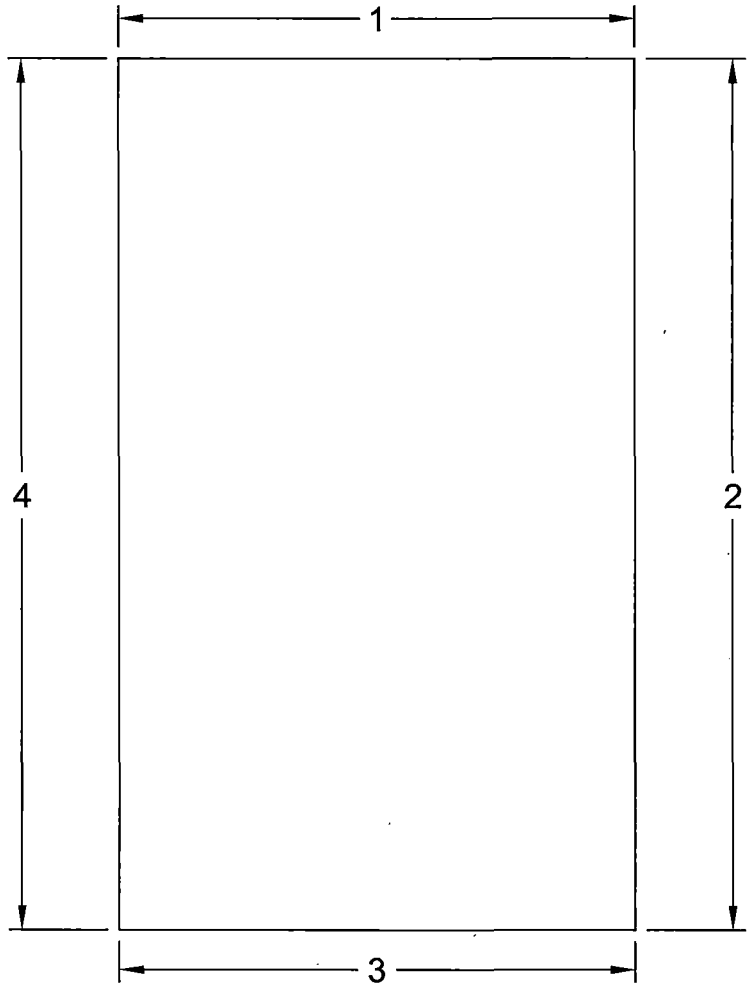
Profile

*For section B-B through F-F see Sheet 3 of 3



Bottom Plan

BOWEN LABORATORY PURDUE UNIVERSITY	Drawing:	Series B Concrete As-builts	Sheet:	3 of 4	
	Project:	Experimental Investigation of Capacity of Lap Splices of No. 11 Reinforcing Bars	Drawn by:	BPR	Checked by: SP
			Date:	04/04/2012	



Section B-B, C-C, D-D, E-E & F-F
*Facing North

BOWEN LABORATORY PURDUE UNIVERSITY	Drawing:	Concrete As-built Sections	Sheet:	4 of 4	
	Project:	Experimental Investigation of Capacity of Lap Splices of No. 11 Reinforcing Bars	Drawn by:	BPR	Checked by: SP
			Date:	04/04/2012	

Project: Tests to Determine the Behavior of Spliced #11 Bars

Setup and As-built Dimensions v.1
(Rev. 04/04/2012)

Specimen:_____

Section	Concrete As-built Dimensions							
	1	2	3	4	5	6	7	8
Plan								
B-B								
C-C								
D-D								
E-E								
F-F								

Recorded by:	Signature	Date	Time

Checked by:	Signature	Date	Time

Checked by:	Signature	Date	Time

Comments:

*See concrete as-built drawings for dimension locations

Project: Tests to Determine the Behavior of Spliced #11 Bars

Setup and As-built Dimensions v.1
(Rev. 04/04/2012)

Specimen:_____

Section	Concrete As-built Dimensions Key - Series A							
	1	2	3	4	5	6	7	8
Plan	39'-0"	39'-0"	39'-0"	39'-0"	N/A	N/A	N/A	N/A
B-B	17-5/8"	30"	17-5/8"	30"	N/A	N/A	N/A	N/A
C-C	17-5/8"	30"	17-5/8"	30"	N/A	N/A	N/A	N/A
D-D	17-5/8"	30"	17-5/8"	30"	N/A	N/A	N/A	N/A
E-E	17-5/8"	30"	17-5/8"	30"	N/A	N/A	N/A	N/A
F-F	17-5/8"	30"	17-5/8"	30"	N/A	N/A	N/A	N/A

Section	Concrete As-built Dimensions Key - Series B							
	1	2	3	4	5	6	7	8
Plan	34'-4"	34'-4"	34'-4"	34'-4"	N/A	N/A	N/A	N/A
B-B	17-5/8"	30"	17-5/8"	30"	N/A	N/A	N/A	N/A
C-C	17-5/8"	30"	17-5/8"	30"	N/A	N/A	N/A	N/A
D-D	17-5/8"	30"	17-5/8"	30"	N/A	N/A	N/A	N/A
E-E	17-5/8"	30"	17-5/8"	30"	N/A	N/A	N/A	N/A
F-F	17-5/8"	30"	17-5/8"	30"	N/A	N/A	N/A	N/A

Project: Tests to Determine the Behavior of Spliced #11 Bars

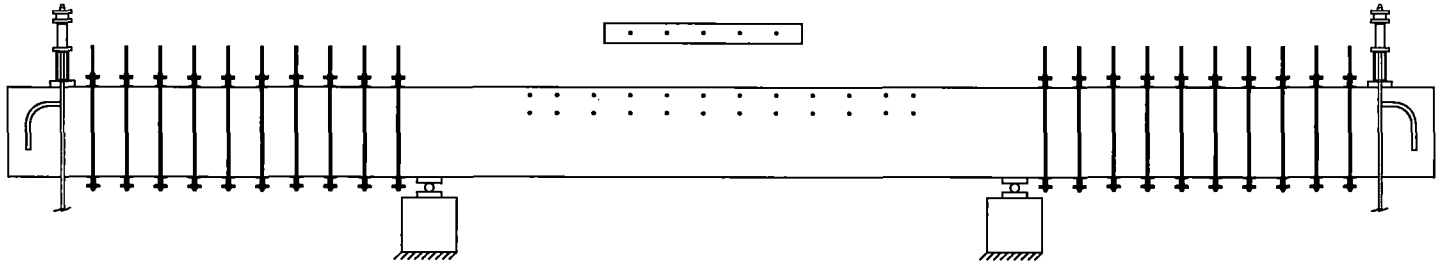
Instrumentation Documentation v.1
(Rev. 04/01/2012)

Specimen: _____
Sheet _____ of _____

Data Acquisition System:								
Channel #	Gain	Excitation V.	Sensor	S.N.	Sensitivity	Zero Offset	Location	Comments

Operator	Signature	Date	Time
Checked by	Signature	Date	Time
Checked by	Signature	Date	Time

Notes:



NORTH

BOWEN LABORATORY PURDUE UNIVERSITY	Specimen				
	Behavior of Lap Splices of No. 11 Reinforcing Bars	Drawn by:		Checked by:	
		Date:			

Purdue University Specimen : A-1 Date: 6/4/12

	Average Load (lbf) K	North Overhang (in)	South Overhang (in)	North Splice End (in)	Midspan (in)	South Splice End (in)	LVDT North Support	LVDT South Support	North Load Cell (lbf) K	South Load Cell (lbf) K	DG North Overhang (in)	DG South Overhang (in)	Time
1	0.2	0.01	0.01	0.00	-0.00	-0.00	0.000	-0.000	0 ~~0.2~~ 0.2	0.2 ~~0.2~~	~~0.300~~ 0.100	0.000	7:44A
2	3.6	first crack											
3	6	0.20	0.19	0.03	0.04	0.02	0.000	-0.000	6	6	0.204	0.171	8:16A
4	12	0.52	0.51	0.08	0.11	0.07	-0.000	-0.000	12	12	0.614	0.500	8:38A
5	18	0.87	0.90	0.13	0.19	0.13	-0.000	0.000	18	18	0.960	0.897	9:01A
6	24	1.23	1.27	0.18	0.28	0.19	-0.001	-0.001	24	24	1.329	1.268	9:35A
7	30	1.64	1.67	0.24	0.36	0.25	-0.002	-0.001	30	30	1.738	1.668	10:00A
8	N+S	DG reset									0.800	0.900	10:26A
9	36	2.05	2.09	0.31	0.46	0.31	-0.002	-0.001	36	36	1.236	1.338	10:28A
10	37.3	yield											
11	38	2.36	2.51	0.35	0.53	0.38	-0.003	-0.001			1.554	1.755	10:54A
12	40.5	3.87	4.14	0.65	0.90	0.68	-0.005	-0.004	40.7	40.3			~~10~~ 11:33A
13	20.2	3.03	3.30	0.52	0.70	0.55	-0.005	-0.005	20.2	20.2			~~10~~ 11:58A
14	0.2	1.91	2.14	0.32	0.43	0.36	-0.005	-0.004	0.2	0.2			12:05P
15	12	2.42	2.68	0.42	0.55	0.44	-0.005	-0.004	12.0	12.0			12:20P
16	24	3.05	3.34	0.52	0.70	0.55	-0.005	-0.004	24.0	24.0			12:37P
17	36	3.70	3.99	0.62	0.86	0.65	-0.004	-0.004	36.0	36.0			12:54P
18	40.7	4.33	4.61	0.73	1.01	0.77	~~-.0005~~	-0.005	40.1	40.0			1:22p
19	41.9	5.34	5.69	0.90	1.23	0.95	-0.006	-0.004	41.4	41.2			1:36p
20	43	6.34	6.67	1.04	1.48	1.13	-.010	-.010	42.2	42.1			1:44p

Purdue University Specimen : A-2 Date: 6/1/12

	Average Load (lbf)	North Overhang (in)	South Overhang (in)	North Splice End (in)	Midspan (in)	South Splice End (in)	LVDT North Support	LVDT South Support	North Load Cell (lbf)	South Load Cell (lbf)	DG North Overhang (in)	DG South Overhang (in)	Time
1	0.28	0	0	-0.01	0	-0.01	-0.001	-0.001	0.3	0.3	0.2	0.2	8:01A
2	1st crack at		2.7k						6	6			8:07A
3	6	0.14	0.11	0.01	0.03	0.01	-0.001	-0.001	6	6	0.340	0.312	8:07A
4	12	0.44	0.44	0.06	0.10	0.06	-0.000	-0.001	12	12	0.638	0.632	8:35A
5	18	0.79	0.78	0.11	0.18	0.11	-0.001	-0.001	18	18	0.985	0.968	8:54A
6	24	1.16	1.17	0.17	0.26	0.17	-0.001	-0.001	24	24	1.355	1.367	9:21A
7	30	1.56	1.53	0.22	0.34	0.22	-0.002	-0.001	30	30	1.765	1.720	9:55A
8	N + S DG		reset								0.800	0.800	
9	36	1.93	1.89	0.27	0.42	0.28	-0.002	-0.001	36	36	1.274	1.165	10:29A
10	38.4	2.29	2.22	0.33	0.48	0.32	-0.001	-0.000			1.635	1.499	10:59A
11	40.8	3.63	3.39	0.55	0.72	0.53	-0.002	-0.001	40.6	41			11:32A
12	Max. Load ~44.5k.												
13													
14													
15													
16													
17													
18													
19													
20													

REDACTED VERSION

Purdue University Specimen : A-3 Date: 5/30/12

	Average Load (lbf) K	North Overhang (in)	South Overhang (in)	North Splice End (in)	Midspan (in)	South Splice End (in)	LVDT North Support	LVDT South Support	North Load Cell (lbf) K	South Load Cell (lbf) K	DG North Overhang (in)	DG South Overhang (in)	Time
1	0.16	0.00	0.00	0.00	0.00	0.00	-0.002	-0.002	0.2	0.1	0.1	0.1	8:06
2	6.2	0.13	0.15	0.02	0.03	0.02	-0.002	-0.002	6.2	6.2	0.234 6.2	0.248	8:13
3	12	0.44	0.47	0.07	0.1	0.07	-0.002	-0.001	12	12	0.538	0.57	8:33
4	18	0.80	0.83	0.12	0.18	0.12	-0.003	0.000	17.9	18	0.894	0.932	9:03
5	24	1.19	1.19	0.18	0.26	0.17	-0.003	0.001	24	24	1.289	1.284	9:32
6	30	1.55	1.57	0.23	0.33	0.23	-0.003	0.002	30	30	1.657	1.657	10:11
7	36	1.93	1.96	0.29	0.42	0.29	-0.004	0.004	36	36	/	/	10:40
8													
9													
10													
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													

REDACTED VERSION

Purdue University Specimen : A-4 Date: 6/8/12

	Average Load (lbf)	North Overhang (in)	South Overhang (in)	North Splice End (in)	Midspan (in)	South Splice End (in)	LVDT North Support	LVDT South Support	North Load Cell (lbf)	South Load Cell (lbf)	DG North Overhang (in)	DG South Overhang (in)	Time
1	0.3	-0.01	-0.01	-0.00	-0.00	0.00	-0.001	-0.001	0.3	0.3	0.000	0.000	7:43A
2	2.2	first crack											
3	6.0	0.17	0.16	0.02	0.04	0.03	-0.001	-0.001	6.0	6.0	0.169	0.171	7:52A
4	12.0	0.49	0.51	0.07	0.11	0.07	-0.001	-0.002	12.0	12.0	0.494	0.519	8:11A
5	18.0	0.96	0.92	0.14	0.21	0.14	-0.001	-0.001	18.0	18.0	0.963	0.929	8:36A
6	24.1	1.33	1.29	0.19	0.29	0.19	-0.001	-0.001	24.1	24.1	1.328	1.299	9:04A
7	29.9	1.73	1.69	0.25	0.38	0.26	-0.000	-0.001	29.9	29.9	1.740	1.706	9:24A
8	N+S	DG reset									0.000	0.000	
9	36.0	2.15	2.13	0.32	0.48	0.32	-0.000	0.001	36.0	36.0	0.428	0.439	9:51A
10	N+S	DG reset									0.000	0.000	
11	36.8	yield							36.8	36.7			
12	37.8	2.66	2.67	0.40	0.58	0.42	-0.001	0.002	37.8	37.8	0.520	0.538	10:20A
13	40.0	3.97	4.04	0.61	0.85	0.66	-0.003	0.003	39.9	40.1	1.825	1.922	10:54A
14	20.2	3.13	3.25	0.49	0.66	0.54	-0.003	0.003	20.2	20.2	0.983	1.110	11:25A
15	0.3	1.97	2.09	0.31	0.40	0.35	-0.003	0.001	0.3	0.3			11:30A
16	12.0	2.49	2.60	0.39	0.51	0.43	-0.003	0.001	12.0	12.0			11:46A
17	24.0	3.16	3.26	0.49	0.66	0.54	-0.003	0.002	24.1	24.0			11:59A
18	36.0	3.83	3.93	0.59	0.82	0.64	-0.003	0.003	36.0	36.0			12:16P
19	40.4	4.44	4.56	0.69	0.96	0.75	-0.003	0.005	40.5	40.4			12:35P
20	41.7	5.47	5.55	0.86	1.17	0.93	-0.003	0.005	41.6	41.9			12:53P

Purdue University Specimen : A-5 Date: 6/7/12

	Average Load (lbf)	North Overhang (in)	South Overhang (in)	North Splice End (in)	Midspan (in)	South Splice End (in)	LVDT North Support	LVDT South Support	North Load Cell (lbf)	South Load Cell (lbf)	DG North Overhang (in)	DG South Overhang (in)	Time
1	0.22	~~0.3~~ 0.08	~~0.2~~ 0.00	0.01	0.01	0.00	-0.002	-0.002	0.3	0.2	0.000	0.000	7:35A
2	3.2	first crack											
3	6.0	0.17	0.15	0.03	0.05	0.03	-0.002	-0.002	5.9	6.1	0.169	0.151	8:00A
4	12.0	0.49	0.49	0.07	0.11	0.07	-0.002	-0.001	12.0	12.0	0.488	0.488	8:21A
5	18.0	0.86	0.84	0.13	0.20	0.13	-0.002	-0.001	18.0	18.0	0.860	0.846	8:45A
6	24.0	1.23	1.25	0.18	0.28	0.18	-0.001	0.000	24.0	24.0	1.231	1.257	9:11A
7	30.0	1.61	1.63	0.25	0.37	0.24	-0.001	0.001	30.0	30.0	1.623	1.645	9:38A
8	N+S	DG reset									0.000	0.000	
9	36.0	2.07	2.10	0.31	0.47	0.32	-0.000	0.001	36.0	36.0	0.450	0.464	10:06A
10	37.5	yield											
11	~~2.438~~	2.44	2.61	0.37	0.55	0.39	-0.000	0.001	37.7	37.5	0.835	0.987	10:32A
12	N+S	DG reset									0.000	0.000	
13	40.2	3.90	4.12	0.63	0.85	0.66	-0.000	-0.001	40.2	40.2	1.540	1.531	10:58A
14	20.3	3.08	3.29	0.50	0.66	0.52	-0.000	-0.001	20.3	20.2	0.622	0.767	11:32A
15	0.2	1.95	2.12	0.32	0.40	0.34	-0.002	-0.001	0.2	0.2			11:38A
16	12.0	2.47	2.67	0.40	0.51	0.42	-0.002	-0.001	11.9	12.0			11:51A
17	24.0	3.11	3.34	0.50	0.67	0.53	-0.001	-0.001	24.1	24.0			12:04P
18	36.0	3.77	4.01	0.61	0.82	0.64	-0.000	-0.001	36.0	36.0			12:19P
19	40.7	4.38	4.62	0.71	0.97	0.75	0.000	-0.001	40.8	40.6			12:41P
20	42.2	5.39	5.63	0.88	1.20	0.94	0.000	-0.003	42.3	42.0			12:58P

Purdue University Specimen : A-6 Date: 6/5/12

	Average Load (lbf) k	North Overhang (in)	South Overhang (in)	North Splice End (in)	Midspan (in)	South Splice End (in)	LVDT North Support	LVDT South Support	North Load Cell (lbf) k	South Load Cell (lbf) k	DG North Overhang (in)	DG South Overhang (in)	Time
1	0.23	0.00	0.00	0.00	-0.00	0.00	-0.000	-0.000	0.3	0.2	0.000	0.000	1:04 P
2	3.14	first crack											
3	6	0.15	0.15	0.02	0.03	0.03	0.001	-0.000	6.0	6.0	0.144	0.154	1:12 P
4	12	0.45	0.45	0.07	0.09	0.07	0.004	0.000	12.0	12.1	0.447	0.450	1:30 P
5	18	0.86	0.86	0.13	0.18	0.13	0.007	-0.001	18.0	17.9	0.851	0.845	1:55 P
6	24	1.27	1.23	0.18	0.27	0.18	0.008	-0.001	24.0	24.0	1.268	1.219	2:25P
7	30	1.64	1.64	0.24	0.36	0.25	0.009	-0.002	30.0	30.0	1.639	1.651	2:48P
8	N+S	DG reset									0.000	0.000	2:56P
9	36	2.09	2.12	0.31	0.47	0.33	0.009	-0.003	36	36	0.458	0.475	3:51P
10	37	Yield											
11	38	2.63	2.79	0.41	0.59	0.44	0.009	-0.004	37	37	1.003	1.163	3:55P
12	~~N+S~~	~~DG reset~~									1.021	1.181	
13											0.000	0.000	4:26P
14	39.8	3.84	4.19	0.62	0.86	0.68	0.009	-0.007	39.9	39.7	1.173	1.400	4:31P
15	20.2	3.00	3.37	0.49	0.66	0.54	0.008	-0.007	20.1	20.3	0.333	0.556	4:57P
16	0.22	1.86	2.20	0.31	0.40	0.35	0.007	-0.007	0.2	0.2			5:06P
17	12	2.39	2.74	0.39	0.52	0.44	0.007	-0.007	12.0	12.0			5:22P
18	24	3.04	3.40	0.50	0.67	0.55	0.008	-0.007	24.0	24.0			5:36P
19	36	3.71	4.07	0.60	0.83	0.66	0.009	-0.007	36.0	36.0			5:49P
20	10.3	4.32	4.70	0.70	0.97	0.77	0.009	-0.009	10.7	39.9			6:13P

Purdue University Specimen : A-6 Date: 6.5.12

	Average Load (lbf)	North Overhang (in)	South Overhang (in)	North Splice End (in)	Midspan (in)	South Splice End (in)	LVDT North Support	LVDT South Support	North Load Cell (lbf)	South Load Cell (lbf)	DG North Overhang (in)	DG South Overhang (in)	Time
21	41.1	5.07	5.44	0.83	1.15	0.93	0.008	-0.011	41.1	41.2			6:23P
22	Max	Load	:~42.k										
23													
24													
25													
26													
27													
28													
29													
30													
31													
32													
33													
34													
35													
36													
37													
38													
39													
40													

REDACTED VERSION

Purdue University Specimen : B-1 Date: 5/10/12

	Average Load (kip)	North Overhang (in)	South Overhang (in)	North Splice End (in)	Midspan (in)	South Splice End (in)	LVDT North Support	LVDT South Support	North Load Cell (lbf)	South Load Cell (lbf)	TIME
1	0.2	0.01	-0.01	0	0	0	-0.001	-0.000	0.2	0.2	12:10
2	DGs	0	0								
3	3.5	0.05	0.04	0.01	0	0	0	0	3.5	3.5	
4	DGs	0.035	0.045								
5	2.3	0.04	0.04	0.01	0	0	-0.001	0.	2.2	2.3	2PM
6	DGs	0.033	0.044								
7	6	0.13	0.14	0.02	0.02	0.02	0.001	0.001	6	6	2:04
8	DGs	0.122	0.146								
9	12	0.44	0.42	0.05	0.07	0.06	0.003	0.001	12	12	2:21
10	DGs	0.414	0.429								
11	18	0.79	0.76	0.1	0.13	0.1	0.004	0.002	18	18	2:53
12	DGs	0.762	0.770								
13	24	1.1	1.07	0.15	0.18	0.14	0.007	0.002	24	24	3:16
14	DGs	1.069	1.079								
15	30	1.43	1.42	0.19	0.24	0.19	0.008	0.003	30	30	3:43
16	DGs.	1.401	1.432	→ REMOVED							
17	36	1.82	1.81	0.25	0.31	0.25	0.009	0.003	36	36	4:16
18	~40 :	Failure.									
19											
20											

Purdue University Specimen : B-2 Date: 5/23/12

	Average Load ~~(lbf)~~ K	North Overhang (in)	South Overhang (in)	North Splice End (in)	Midspan (in)	South Splice End (in)	LVDT North Support	LVDT South Support	North Load Cell ~~(lbf)~~ kip	South Load Cell ~~(lbf)~~ kip	DG North Overhang (in)	DG South Overhang (in)	Time
1	0.2	0	0.01	0	0	-0.01	-0.005	0.001	0.3	0.2	+0.100	0.100	~~7:57A~~
2	3.4	1ST CRACK											
3	6.0	0.14	0.16	0.02	0.02	0.01	-0.005	0.001	6	6	0.238	0.244	8:30 A
4	12	0.47	0.42	0.06	0.07	0.05	-0.004	0.002	12	12	0.571	0.510	8:54A
5	18	0.81	0.78	0.11	0.13	0.10	-0.003	0.002	18	18	0.897	0.871	9:11 A
6	24	1.14	1.11	0.15	0.19	0.15	-0.002	0.003	24	24	1.217	1.206	9:35A
7	30	1.48	1.46	0.2	0.25	0.2	-0.001	0.004	30	30	1.558	1.548	10:00A
8	36	1.88	1.85	0.26	0.33	0.26	-0.001	0.004	36	36	N.A.	1.945	10:26A
9										Reset @ 1.9	RELATIVE MEASUREMENTS		
10	18	1.27	1.23	0.18	0.22	0.17	-0.002	0.005	18	18	1.296	1.320	11:10 A
11	0.2	0.48	0.48	0.07	0.08	0.06	-0.004	0.001	0.2	0.2	0.500	0.550	11:15A
12	12	0.89	0.87	0.12	0.15	0.11	-0.002	0.002	12	12	0.914	0.960	11:30 A
13	24	1.43	1.39	0.2	0.24	0.19	-0.001	0.004	24	24	1.444	1.480	11:45A
14	36	1.96	1.91	0.28	0.34	0.27	-0.001	0.006	36	36	—	1.009	12:00 N.
15	DG's Removed @ 36k												
16	Max Load = 39k												
17													
18													
19													
20													

REDACTED VERSION

Purdue University Specimen : B-3 Date: 5/21/12

	Average Load ~~lbf~~ k	North Overhang (in)	South Overhang (in)	North Splice End (in)	Midspan (in)	South Splice End (in)	LVDT North Support	LVDT South Support	North Load Cell ~~lbf~~ k	South Load Cell ~~lbf~~ k	DG North Overhang (in)	DG South Overhang (in)	Time
1	0.2	0	0	0	0	0	-0.001	-0.003	0.2	0.2	0	0	8A
2	3k	: 1st	crack										
3	6.2	0.14	0.14	0.02	0.03	0.02	-0.001	-0.002	6.2	6.2	0.143	0.132	8:10A
4	12	0.42	0.40	0.05	0.07	0.05	-0.003	-0.002	12	12	0.429	0.407	8:35A
5	18	0.78	0.74	0.10	0.13	0.10	-0.004	-0.002	18	18	0.780	0.747	9:04A
6	24	1.09	1.07	0.14	0.19	0.15	-0.004	-0.002	24	24	1.087	1.080	9:27A
7	30	1.43	1.41	0.19	0.25	0.2	-0.004	-0.001	30	30	1.420	1.423	9:57A
8	36	1.79	1.78	0.25	0.32	0.25	-0.004	0.000	36	36	1.780	1.795	10:28A
9	0.2	0.44	0.44	0.06	0.09	0.06	-0.004	-0.006	0.2	0.2	0.435	0.436	11:05A
10	12	0.86	0.84	0.12	0.15	0.12	-0.004	-0.004	12.1	11.9	0.854	0.840	11:14A
11	24	1.36	1.34	0.18	0.24	0.19	-0.004	-0.002	24	24	1.352	1.352	11:25A
12	36	1.87	1.84/5	0.26	0.34	0.26	-0.004	-0.001	36	36	1.855	1.864	11:47A
13	MAX	LOAD :	39.8k										
14													
15													
16													
17													
18													
19													
20													

REDACTED VERSION

Purdue University Specimen : B-4 Date: 5/14/12

	Average Load (lbf)	North Overhang (in)	South Overhang (in)	North Splice End (in)	Midspan (in)	South Splice End (in)	LVDT North Support	LVDT South Support	North Load Cell (lbf)	South Load Cell (lbf)	DG North Overhang (in)	DG South Overhang (in)	Time
21	0.2	0	0	0	0	0	0	0	0.2	0.2	0.2	0.2	4:10 P
22	3.5	0.02	0.03	0	0	0	0	0.001	3.5	3.5	0.225	0.228	4:17 P
23	0.2	0	0	0	0	0	0	0.001	0.2	0.2	0.202	0.202	4:27 P
24													
25													
26													
27													
28													
29													
30													
31													
32													
33													
34													
35													
36													
37													
38													
39													
40													

REDACTED VERSION

Purdue University Specimen : B-4 Date: 5/14

	Average Load (lbf)	North Overhang (in)	South Overhang (in)	North Splice End (in)	Midspan (in)	South Splice End (in)	LVDT North Support	LVDT South Support	North Load Cell (lbf)	South Load Cell (lbf)	DG North Overhang (in)	DG South Overhang (in)	Time
1	0.2	0	0	0	0	0	-0.002	-0.001	0.2	0.2	0.203	+0.205	1:20
2	5.2	0.04	0.05	0	0	0	-0.001	0	5.2	5.2	0.245	0.255	~1:35
3	L→	1ST CRACK											
4	12	0.31	0.33	0.04	0.05	0.05	0	0.001	12	12	0.514	0.535	1.58
5	18	0.62	0.63	0.08	0.11	0.08	0.003	0.002	18	18	0.811	0.833	2:20
6	L→	1ST SPLIT. CRACK							24	24			
7	24	0.95	0.94	0.13	0.16	0.13	0.004	0.003	24	24	1.131 ✓	1.148 ✓	2:57
8	30	1.26	1.25	0.17	0.21	0.17	0.006	0.004	30	30	1.439 ✓	1.459 ✓	3:33
9	36	1.62	1.61	0.21	0.27	0.22	0.006	0.004	36	36	1.898	1.824	4:09
10	DGs	Removed.											
11	38	1.77	1.76	0.23	0.3	0.24	.008	.005	38	38	—	—	4:56
12													
13													
14													
15													
16													
17													
18													
19													
20													

Purdue University Specimen : B-5 Date: 5/17/12

	Average Load (lbf)	North Overhang (in)	South Overhang (in)	North Splice End (in)	Midspan (in)	South Splice End (in)	LVDT North Support	LVDT South Support	North Load Cell ~~(lbf)~~ K	South Load Cell ~~(lbf)~~ K	DG North Overhang (in)	DG South Overhang (in)	Time
1	0.2	0	0	0	0	0	0	0	0.2	0.2	0	0.300	12:20 PM
2	0.2	0	0	0	0	0	0.001	0.001	0.2	0.2	0	0.300	1:25PM
3	6	0.08	0.08	0	0.02	0.01	0.002	0.002	6	6	0.076	0.380	1:37PM
4	↳ 1ST CRACK OBSERVED												
5	12	0.33	0.36	0.04	0.06	0.05	0.004	0.002	11.9	12	—	0.660	1:56 PM
6	18	0.70	0.65	0.08	0.11	0.09	0.004	0.003	18	18	0.691	0.948	2:20PM
7	24	1.01	0.98	0.12	0.17	0.13	0.004	0.003	24	24	0.997	1.275	2:48PM
8	30	1.33	1.30	0.17	0.22	0.17	0.005	0.003	30	30	1.303	1.593	3:16PM
9	RESET DGS:										1.000	1.000	
10	36	1.68	1.63	0.22	0.28	0.22	0.005	0.004	36	36	1.343	1.342	3:44 PM
11	0	0.39	0.39	0.05	0.07	0.05	0.003	0.002	0	0	0.082	0.085	4:14 PM
12	12	0.76	0.74	0.09	0.13	0.10	0.004	0.002	12	12	0.444	0.441	4:42 PM
13	24	1.25	1.21	0.15	0.21	0.16	0.004	0.003	24	24	0.918	0.915	4:49 PM
14	32	1.56	1.53	0.2	0.27	0.21	0.005	0.004	32	32	—	—	5:30 PM
15													
16													
17													
18													
19													
20													

Purdue University Specimen : B-6 Date: 5/25/12

	Average Load ~~lbf~~ kip	North Overhang (in)	South Overhang (in)	North Splice End (in)	Midspan (in)	South Splice End (in)	LVDT North Support	LVDT South Support	North Load Cell ~~lbf~~ k	South Load Cell ~~lbf~~ k	DG North Overhang (in)	DG South Overhang (in)	Time
1	0.18	.0	0.02	0	0	0	-0.006	0	0.2	0.2	0.	0.100	8:22A
2	3.9 k:	1st crack											
3	6	0.1	0.12	0.01	0.01	0.01	-0.005	0.002	6	6	0.105	0.207	8:29A
4	12	0.37	0.39	0.05	0.06	0.04	-0.004	0.003	12	12	0.368	0.470	8:57A
5	18	0.73	0.71	0.09	0.11	0.08	-0.003	0.003	18	18	0.718	0.805	9:06A
6	24	1.09	1.04	0.14	0.17	0.13	-0.002	0.004	24	23.9	1.068	1.130	9:30A
7									30↓	30↓			
8	30	1.42	1.36	0.19	0.22	0.17	-0.001	0.005	30	30	1.392	1.457	9:54A
9	36	1.76	1.70	0.24 ~~1.78~~	0.29	0.23	0.001	0.006	36	36	1.734	1.795	10:14A
10	18.5	1.18	1.16	0.16	0.19	0.15	-0.001	0.005	18.5	18.5	1.169	1.256	10:39A
11	0	0.43	043	0.06	0.07	0.05	-0.004	0.004	0.2	0.2	0.404	0.505	10:50A
12	12	0.81	0.80	0.11	0.13	0.10	-0.002	0.004	12	12	0.805	0.892	11:06A
13	24	1.33	1.29	0.18	0.21	0.17	-0.000	0.005	24	24	1.303	1.381	11:18A
14	36	1.85	1.78	0.25	0.30	0.24	0.001	0.006	36	36.1	1.820	1.876	11:34A
15	38	2.02	1.93								NO DGs		
16	MAX	LOAD:	~41.6										
17													
18													
19													
20													

TAKING ACCURATE THERMOMETER READINGS

COMMON TYPES OF THERMOMETERS AND FACTORS AFFECTING THEIR USE

TOTAL IMMERSION thermometers are designed with scales calibrated to indicate the true temperature when the bulb and the portion of the thermometer that contains the mercury column are exposed to the temperature to be measured (practically, less than an inch is permitted to extend above the surface, to permit the reading to be made). Most total immersion thermometers can also be used in a condition of complete immersion, in which case the entire thermometer is exposed to the temperature being measured, such as in a freezer.

PARTIAL IMMERSION thermometers are designed with scales calibrated to indicate the true temperature when the thermometers are immersed to specified depths. The portion that should be immersed is indicated on the back of each thermometer.

COMPUTATION OF EMERGENT STEM CORRECTION

When total immersion thermometers are used only partially immersed, a stem correction may he calculated and applied to the reading for precision results. To compute an emergent stem correction, the following variables must be defined:

T = the reading of the thermometer in situ.
N = the number of degrees on the thermometer scale between the liquid surface and the top of the mercury column.
A = the average temperature of the emergent mercury column. To find value A, suspend alongside the subject thermometer a secondary or auxiliary thermometer with its bulb centered between the liquid level and the temperature indicated on the subject. thermometer. The temperature indicated on this auxiliary thermometer will he value A.

Find the stem correction (SC) by computation from the following formula:
SC = 0.00016 x (N x (T-A)) for Celsius temperatures, or
SC = 0.00009 x (N x (T-A)) for Fahrenheit temperatures.

Example: A thermometer graduated from -1° to 101°C., immersed to 20°C on its scale, reading 90°C. The auxiliary thermometer reads 42C. Hence, T=90, N=70 (90.20). A=42

Working the formula, SC =.00016 x (70 x (90 - 42)) yields a value for SC of +.537. This value must he added to the observed indication of the subject thermometer to determine the true temperature of the liquid. Hence, the true temperature of the liquid is 90° + .54° (rounded result) = 90.54°

GENERAL CONSIDERATIONS FOR MAKING AN ACCURATE READING

The error due to parallax may be eliminated by taking care that the reflection of the scale can be seen in the mercury thread, and by adjusting the line of sight so that the graduation of the scale nearest the meniscus exactly hides its own image: the line of sight will then be normal to the stem at that point. In reading thermometers, account must be taken of the fact that the lines are of appreciable width. The best practice is to consider the position of the lines as defined by their middle parts.

PERFORMING A CALIBRATION AT THE ICE POINT (0 DEGREES CELSIUS OR 32 DEGREES FAHRENHEIT)

Select clear pieces of ice, preferably made from relatively pure water. Discard any cloudy or unsound portions. Rinse the ice with distilled water and shave or crush into small pieces, avoiding direct contact with the hands or any chemically unclean objects. Fill a Dewar or other insulated vessel with the crushed ice and add sufficient distilled (and preferably precooled) water to form a slush, but not enough to float the ice. Insert the thermometer, packing the ice gently about the stem, to a depth sufficient to cover the 0°C (32°F) graduation. As the ice melts, drain off some of the water and add more crushed ice.

Raise the thermometer a few millimeters after at least 3 minutes have elapsed, tap the stem gently and observe the reading. Successive readings taken at least one minute apart should agree within one tenth of one graduation.

APPLYING THE CORRECTION AT ICE POINT

Record readings and compare with previous readings. If the readings are found to be higher or lower than the reading corresponding to a previous calibration, readings at all other temperatures will he correspondingly increased or decreased.

Reproduced in part from ASTM E77.

KESSLER **KESSLER THERMOMETER CORP.**

Precision and Reliability . . . from a name you can trust.

CALSER CORPORATION 302 N. BELT EAST SWANSEA, IL 62226 (618)277-0329

TESTING MACHINE CERTIFICATE OF CALIBRATION

Owner : Purdue University
Location : 1040 South River Rd. - Bowen Lab
West Lafayette, IN 47907
Machine : Forney 600,000lbf Model F-600-DFM/1
Serial No. : 99058
w/ Forney DFM/1 Digital R/O #9902182
w/ Dynisco P/T #02-23-990747

Report # : VN# 6560

Page : 2 of 2

Date of Service: 06/06/11

This is to certify that the testing machine listed above has been calibrated by Calser Corporation personnel.
The method of verification and listed data are in accordance with ASTM E 4-09.
Accuracy of all calibration devices is traceable to the National Institute of Standards and Testing (NIST)
and all calculations have been corrected for temperature where applicable.

Capacity Range	Loading Range	Max. Error
Run 1 600,000lbf Range	5,000 - 600,000	1.20 %
Run 2 600,000lbf Range	5,000 - 600,000	0.10 %
Run 3 600,000lbf Range	5,000 - 600,000	0.08 %

Verification Equipment Used:

(400,000 Load Cell Set)
Admet Gage Buster Digital Readout, Serial # GB-9911092,
and Load Cell(s) Listed Below:

Serial #	Range	Calib. Date	Uncertainty
901120B	716.99 -10,000 lbf	08/19/2009	1.792 lbf
090716C (LO)	5,572.38 - 100,000 lbf	08/10/2010	13.931 lbf
090716C (HI)	39,281.95 - 400,000 lbf	08/10/2010	98.205 lbf

This certificate is issued as a statement of the fact that on the above date the listed testing machine has an accuracy as indicated. It should not be construed or regarded as a Guarantee or Warranty of any kind (in favor of the client, the client's customers, or the public at large) that the testing machine will continue to retain the same percentage (%) of accuracy or efficiency as determined on the date when the calibration, and adjustments if required, was performed and reported by "Calser Corporation" since the calibrator has absolutely no control over the future operation, damage, maintenance, repairs, and overall condition of the testing machine and hereby expressly disclaims any and all liability for damage or loss sustained by all parties arising or resulting from the deterioration, obsolescence, malfunction or substandard performance of said testing machine; which shall remain the sole responsibility of the machine's regular custodian, owner, and/or user. This certificate shall not be reporoduced except in full, without the written approval of Calser Corporation.

CALSER CORPORATION

Quality Control Director

Thomas R. Gagen

Form # 104-01-Rev 3

CALSER CORPORATION

302 N. Belt East, Swansea, IL 62226 (618) 277-0329

TESTING MACHINE CALIBRATION DATA AND REPORT

Report #: VN# 6560

Customer	Purdue University	Date of Service	06/06/11
Location	1040 South River Rd. - Bowen Lab West Lafayette, IN 47907	Cust Order No.	Verbal
Machine	Forney 600,000lbf Model F-600-DFM/1	Order Date	06/02/11
Serial No.	99058	Temp.	74° F
Auxiliary Equipment:	w/ Forney DFM/1 Digital R/O #9902182 w/ Dynisco P/T #02-23-990747	Date Last Done	05/19/10

Applied Force	*	Indicated Force	Error	%	*	Indicated Force	Error	%	*	Indicated Force	Error	%
Run #1		Run #1	"As Found" Condition			Run #2	"As Left" Condition			Run #3	"As Left" Condition	
600,000lbf Range	*	10lbf / DIV			*				*			
0	6C	0	0	0.00	6C	0	0	0.00	6C	0	0	0.00
5,000	6C	4,940	-60	1.20	6C	5,000	0	0.00	6C	5,000	0	0.00
10,000	7	9,880	-120	1.20	7	9,990	-10	0.10	7	10,000	0	0.00
20,000	7	19,790	-210	1.05	7	19,990	-10	0.05	7	19,990	-10	0.05
40,000	8	39,530	-470	1.18	8	40,000	0	0.00	8	40,000	0	0.00
60,000	8	59,340	-660	1.10	8	60,010	10	0.02	8	60,000	0	0.00
80,000	8	79,150	-850	1.06	8	80,050	50	0.06	8	80,030	30	0.04
100,000	8	98,940	-1,060	1.06	8	100,060	60	0.06	8	100,070	70	0.07
125,000	8	123,600	-1,400	1.12	8	125,090	90	0.07	8	125,100	100	0.08
150,000	8	148,330	-1,670	1.11	8	150,150	150	0.10	8	150,120	120	0.08
200,000	8	197,650	-2,350	1.18	8	199,980	-20	0.01	8	200,010	10	0.01
300,000	8	296,650	-3,350	1.12	8	300,060	60	0.02	8	300,040	40	0.01
400,000	8	395,880	-4,120	1.03	8	400,120	120	0.03	8	400,090	90	0.02
500,000	8	495,110	-4,890	0.98	8	500,260	260	0.05	8	500,210	210	0.04
600,000	8	593,770	-6,230	1.04	8	600,310	310	0.05	8	600,290	290	0.05
0	8	0	20	0.00	8	0	-10	0.00	8	0	-30	0.00

Notes:

Calibration in accordance with ASTM E4-09, and Calser Corporation Procedure # 1-01, Rev 1.

***CALIBRATION EQUIPMENT**

All verification equipment-including dead weights, proving rings, load cells, etc. is calibrated and traceable to the latest procedures stipulated by the National Institute of Standards and Testing (NIST) and ASTM E74-06. All equipment is traceable under guidelines set forth in ISO/IEC 17025 . All instrument readings have been corrected for temperature where necessary.

ACCURACY SUMMARY

Capacity Range	Loading Range	Max. Error
Run 1		
600,000lbf Range	5,000 - 600,000	1.20 %
Run 2		
600,000lbf Range	5,000 - 600,000	0.10 %
Run 3		
600,000lbf Range	5,000 - 600,000	0.08 %

VERIFICATION EQUIPMENT

Manufacturer & Serial #	* L/C	Class A Range (in LBs) and Uncertainty (LBF)	Agency & Date
Strainsense	6C	716.99 -10,000 lbf	Morehouse
901120B		1.792 lbf	08/19/09
Strainsense	7	5,572.38 - 100,000lbf	Morehouse
090716C (LO)		13.931 lbf	08/10/10
Strainsense	8	39,281.95 - 400,000 lbf	Morehouse
090716C (HI)		98.205 lbf	08/10/10

Calibration Technician Jerry Parker

Form# 103-01-Rev 3

CERTIFICATE OF CALIBRATION

ISSUED BY: INSTRON CALIBRATION LABORATORY

DATE OF ISSUE: 30-Jan-12 CERTIFICATE NUMBER: **340013012113643**

NVLAP
Lab code: 200301-0

INSTRON®
Instron
825 University Avenue
Norwood, MA 02062-2643
Telephone: (800) 473-7838
Fax: (781) 575-5750
Email: service_requests@instron.com

APPROVED SIGNATORY

Richard Binford

Digitally signed by Richard Binford
DN: cn=Richard Binford, c=US, l=Norwood, st=MA, ou=OVR
Date: 2012.01.30 12:01:16 -05'00'

Type of Calibration: Strain
Relevant Standard: ASTM E83-10
Date of Calibration: 30-Jan-12

Customer

Name: PURDUE UNIVERSITY
Address: 550 STADIUM MALL DR.
WEST LAFAYETTE,IN 47907
KBROWER@PURDUE.EDU
P.O./Contract No.:
Contact: KEVIN BROWER

Machine

Manufacturer: BALDWIN
Serial Number: 120BTEC502040
System ID: 120BTEC502040
Range Type: Single

Transducer

Manufacturer: INSTRON
Transducer ID: 2630-115/590
Extensometer Type: Type 1
Travel (Tension): 1 in
Travel (Compression): 0.1 in
Gauge Length: 2 in
Mode: Static (Tension/Compression)

Classification

The following indicators of the extensometer system were verified and classed:

Indicator Type	Description	Indicator Units	Range Full Scale (%)	System Class
1. Digital Readout		strain	100	B-1

Certification Statement

All indicators listed above were verified on-site at customer location by Instron in accordance with ASTM E83.

The verification and equipment used conform to a controlled Quality Assurance program which meets the specifications outlined in ANSI/NCSL Z540-1, ISO 10012, ISO 9001:2008 and ISO/IEC 17025:2005.

The testing machine was verified in the 'as found' condition.

Instron Calpro Version 3.23

CERTIFICATE OF CALIBRATION

NVLAP ACCREDITED CALIBRATION LABORATORY No. 200301-0

CERTIFICATE NUMBER:
340013012113643

Data

Indicator 1. - Digital Readout (strain)

% of Range	Run 1 Indicated (strain)	Run 1 Applied (in)	Run 2 Indicated (strain)	Run 2 Applied (in)
100% Range (Full Scale: 1.00016 in)				
	Run Temperature: 70.0 °F		Run Temperature: 70.1 °F	
40	0.19991	0.400580	0.1995	0.400013
70	0.34995	0.700010	0.349987	0.700023
100	0.49985	1.000162	0.49899	1.000050

Verification Equipment and Usage

Verification Equipment:

Make/Model	Serial Number	Description	Calibration Agency	Measurement Range	Cal Date	Cal Due
Extech 445580	1003552	temp. indicator	Tektronix	NA	12-Feb-11	12-Feb-13
Epsilon 3590VHR	A5010 (ASTM)	disp. indicator	Instron Ltd	2.00 in	14-Feb-11	14-Feb-12
* Instron US Gauge Bar	I902	gauge bar	AA Jansson	NA	11-May-10	11-May-12
* HBM ML38	90630412	force indicator	Instron	NA	21-Jan-11	21-Jan-13
* Epsilon 3590VHR	A5010 (ASTM)	(Note: Also used for displacement measurements and listed above.)				

** Equipment used for gauge length measurements.*

Verification Equipment Usage:

Measurement Type	Serial Number	Range (% Full Scale)	Percent(s) of Range
Displacement	A5010 (ASTM)	100	0/10/20/40/70/100

Instron standards are traceable to NIST and/or other National standards.

Comments

Verified by: Rich Binford
Field Service Engineer

NOTE: Clause 9 of ASTM E-83 states; It is recommended that extensometer systems be verified annually or more frequently if required. In no case shall the time interval between verifications exceed 18 months (unless an extensometer is being used in a long-time test running beyond the 18 month period). An extensometer system shall not be used after an adjustment or repair that could affect its accuracy without first verifying its accuracy utilizing the procedure described in this practice.

Instron Calpro Version 3.23

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Tel: +1-800-473-7838 ▪ Fax: +1-781-575-5755
www.Instron.com

Field Service Report

Company: Purdue University
Address: 550 Stadium Mall Drive
Civil Room G151
West Lafayette, IN 47907
USA
Contact: Brower Kevin
Service Order #: SV1201120017@@1 PO #: Credit Card
Field Engineer: Richard Binford Reference #:
Service Notes: Contract Total Amount: $2330.
Verified force,displcement and the extensometer. Keep a regular check on the pressure transducer oil capsule gap regularly to insure the .030" gap for accurate force readings.

Labor Activities

Work Date	Product/SN	Tag Number	Work Hours	Charge Code	Description
01/30/2012		120BTEC502040	0.02	S1400-003-A	Zone 3 For Tensile Service
01/30/2012		120BTEC502040	1.00	S1460-011-A	Crosshead Displacement Verification
01/30/2012		120BTEC502040	2.00	S1481-017-C-A	Force Verification, 68K lb- 300K lb Compression
01/30/2012	2630-115/590	120BTEC502040	1.00	S1490-003-A	Strain Verification, Static Ext or Deflectometer

Materials

Part Number	Part Number Description	Qty	Serial #

CERTIFICATE OF CALIBRATION

ISSUED BY : INSTRON CALIBRATION LABORATORY

DATE OF ISSUE : **30-Jan-2012** CERTIFICATE NUMBER: **340013012110833**

NVLAP

Lab code: 200301-0

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APPROVED SIGNATORY

Richard Binford

Digitally signed by Richard Binford
DN: cn=Richard Binford, c=US, l=Norwood, st=MA, ou=OVR
Date: 2012.01.30 11:36:28 -05'00'

Type of Calibration: Displacement
Relevant Standard: astm e2309
Date of Calibration: 30-Jan-2012 **Customer Requested Due Date: 30-Jan-2013**

Customer

PURDUE UNIVERSITY
550 STADIUM MALL DR.
WEST LAFAYETTE, IN 47907

Machine

Serial No : C502040
Make : BALDWIN
Model : 120BTE

P.O. Number :
Contact : HARRY TIDRICK

Readout Verified

1. Digital Readout (in)

Certification Statement

This certifies that the displacements verified with machine indicator 1 (listed above) were verified by Instron in accordance with ASTM E2309-05 (Follow-the-Displacement Method) and Instron work instruction ICA-8-07.

The testing machine was verified on-site at customer location. Adjustments are noted in the comments section of this report with a reference to the "As Found" data.

The verification and equipment used conform to a controlled Quality Assurance program which meets the specifications outlined in ANSI/NCSL Z540-1, ISO 10012, ISO 9001:2000, and ISO/IEC 17025:2005. The Instron measurement equipment used for verification is traceable to NIST.

Summary of Results

Indicator 1- Digital Readout (in)

Verified Range (in)	Max Error (in)	Max Error (%)	Max Repeat Error (in)	Max Repeat Error (%)	System Class*	Resolution (in)	Resolution Class	ASTM Lower Limit (in)
0.2 - 1	-0.00268	-0.355	0.00112	0.257	B	.001	B	0.2

**System Class is derived from assessment of the following: error, repeatability, resolution, and standard device classification.*

CalproSDS version 3.3

CERTIFICATE OF CALIBRATION

ISSUED BY : INSTRON CALIBRATION LABORATORY

DATE OF ISSUE : **30-Jan-2012** CERTIFICATE NUMBER: **340013012110833**

Direction of Displacement : Ascending

Datapoint Summary - Indicator 1 - Digital Readout (in)

Suggested Value (in)	Run 1 Error (in)	Run 1 Error (%)	Run 2 Error (in)	Run 2 Error (%)	Run 3 Error (in)	Run 3 Error (%)	Repeat Error (in)	Uncertainty (in)*	Coverage Factor = k
0.2	0.00007	0.035	-0.00045	-0.222	-0.00026	-0.129	0.00052	0.00081	2.26
0.4	-0.00110	-0.276	-0.00086	-0.213	-0.00091	-0.227	0.00024	0.00070	2.26
0.6	-0.00105	-0.153	-0.00214	-0.355	-0.00176	-0.292	0.00109	0.00150	2.78
0.8	-0.00268	-0.331	-0.00156	-0.189	-0.00162	-0.203	0.00112	0.00165	2.78
1	-0.00168	-0.164	-0.00142	-0.142	-0.00198	-0.196	0.00056	0.00086	2.26

**The reported expanded uncertainty of measurement is based on a combined uncertainty multipied by a coverage factor k to provide a level of confidence of approximately 95 %.*

Runs 1 and 2 are performed to comply with the requirements of ASTM E2309, run 3 is performed to calculate the uncertainty of measurement.

Data - Indicator 1 - Digital Readout (in)

Temperature at start of verification : 67.9 °F

	Run 1			Run 2			Run 3	
Suggested Value	Applied	Indicated	Error Class	Applied	Indicated	Error Class	Applied	Indicated
0.2	0.19993	0.200	A	0.20245	0.202	A	0.20126	0.201
0.4	0.39810	0.397	A	0.40286	0.402	A	0.40091	0.400
0.6	0.68605	0.685	A	0.60314	0.601	A	0.60176	0.600
0.8	0.80968	0.807	A	0.82356	0.822	A	0.79962	0.798
1	1.02568	1.024	A	1.00142	1.000	A	1.00798	1.006

For runs 1 and 2: the worst Resolution Class is B and the worst Repeatability Class is A.

Temperature at end of verification : 70 °F

Starting Point of crosshead : 0 in

Verification Equipment

Make/Model	Serial No.	Description	Cal Agency	Uncertainty of Calibration	Resolution	Cal Date	Due Date
Instron LDS-10	06105014	Linear Gage	AA JANSSON	.000013 in	.00001 in	3-Aug-10	3-Aug-12
EXTECH 445580	1003552	Thermometer	TEKTRONIX	1 °F	.1 °F	12-Feb-11	12-Feb-13

The standards used for this verification are traceable to NIST.

CalproSDS version 3.3

CERTIFICATE OF CALIBRATION

ISSUED BY : INSTRON CALIBRATION LABORATORY

DATE OF ISSUE : **30-Jan-2012** CERTIFICATE NUMBER: **340013012110833**

Comments

Verified By: RICHARD BINFORD
SNR.SERV.ENGR,

CalproSDS version 3.3

CERTIFICATE OF CALIBRATION

ISSUED BY: INSTRON CALIBRATION LABORATORY

DATE OF ISSUE: 30-Jan-12 CERTIFICATE NUMBER: **340013012095410**

NVLAP
Lab code: 200301-0

INSTRON
Instron
825 University Avenue
Norwood, MA 02062-2643
Telephone: (800) 473-7838
Fax: (781) 575-5750
Email: service_requests@instron.com

APPROVED SIGNATORY

Richard Binford

Digitally signed by Richard Binford
DN: cn=Richard Binford, c=US, l=Norwood, st=MA, ou=OVR
Date: 2012.01.30 11:08:19 -05'00'

Type of Calibration: Force
Relevant Standard: ASTM E4-10
Date of Calibration: 30-Jan-12

Customer Requested Due Date: 30-Jan-13

Customer

Name:	PURDUE UNIVERSITY
Address:	550 STADIUM MALL DR. WEST LAFAYETTE,IN 47907 KBROWER@PURDUE.EDU
P.O./Contract No.:	
Contact:	KEVIN BROWER

Machine

Manufacturer:	BALDWIN
Serial Number:	120BTEC502040
System ID:	120BTEC502040
Range Type:	Single

Transducer

Manufacturer:	BALDWIN
Transducer ID:	120BTEC502040
Capacity:	120000 lbf
Type:	Compression

Classification

1. Digital Readout - PASSED

Certification Statement

This certifies that the forces verified with machine indicator(s) (listed above) that passed are WITHIN ± 1 % accuracy, 1 % repeatability, and zero return tolerance.
All machine indicators were verified on-site at customer location by Instron in accordance with ASTM E4.
The certification is based on runs 1 and 2 only. A third run is taken to satisfy uncertainty requirements according to ISO 17025 specifications.
The verification and equipment used conform to a controlled Quality Assurance program which meets the specifications outlined in ANSI/NCSL Z540-1, ISO 10012, ISO 9001:2008 and ISO/IEC 17025:2005.

Method

The testing machine was verified in the 'as found' condition with no adjustments carried out.

Instron CalproCR Version 3.23

CERTIFICATE OF CALIBRATION

NVLAP ACCREDITED CALIBRATION LABORATORY No. 200301-0

CERTIFICATE NUMBER:
340013012095410

Summary of Results

Temperature at start of verification: 67.00 °F.

Indicator 1. - Digital Readout (lbf)

Range Full Scale (%)	Tested Force Range (lbf)	Mode	ASTM E4 Max Error (%)	ASTM E4 Max Repeat Error (%)	Zero Return	Resolution (lbf)	ASTM E4 Lower Limit (lbf)
100	-1194.4 to -119044.9	C	0.88	0.11	Pass	1	200

Temperature at end of verification: 67.80 °F.

Data Point Summary - Indicator 1. - Digital Readout (lbf)

COMPRESSION

% of Range	Run 1 Error (%)	Run 2 Error (%)	Run 3 Error (%)	ASTM E4 Repeat Error (%)	Relative Uncertainty* (%)	Uncertainty of Measurement* (± lbf)
100% Range (Full Scale: -119044.9 lbf)						
1	0.47	0.43	0.43	0.04	0.14	1.661
2	0.41	0.48	0.49	0.07	0.14	3.321
4	0.42	0.46	0.45	0.04	0.13	6.213
7	0.77	0.76	0.77	0.01	0.14	11.254
10	0.82	0.75	0.76	0.07	0.14	16.908
20	0.88	0.77	0.78	0.11	0.15	36.187
40	0.81	0.81	0.80	0.00	0.14	64.283
70	0.81	0.80	0.81	0.01	0.14	112.494
100	0.80	0.81	0.81	0.01	0.14	160.702

** The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95%.*

Data - Indicator 1. - Digital Readout (lbf)

COMPRESSION

% of Range	Run 1 Indicated (lbf)	Run 1 Applied (lbf)	Run 2 Indicated (lbf)	Run 2 Applied (lbf)	Run 3 Indicated (lbf)	Run 3 Applied (lbf)
100% Range (Full Scale: -119044.9 lbf)						
0 Return	1		0		-1	
1	-1200	-1194.4	-1200	-1194.9	-1200	-1194.85
2	-2400	-2390.3	-2400	-2388.5	-2400	-2388.2
4	-4800	-4780.1	-4800	-4777.95	-4800	-4778.5
7	-8400	-8335.52	-8400	-8336.7	-8400	-8336.11
10	-12000	-11902.07	-12000	-11910.33	-12000	-11909.74
20	-24000	-23789.98	-24000	-23815.94	-24000	-23815.35
40	-48000	-47615.95	-48000	-47615.36	-48000	-47618.9
70	-84000	-83326.29	-84000	-83333.37	-84000	-83327.47
100	-120000	-119044.89	-120000	-119034.86	-120000	-119034.86

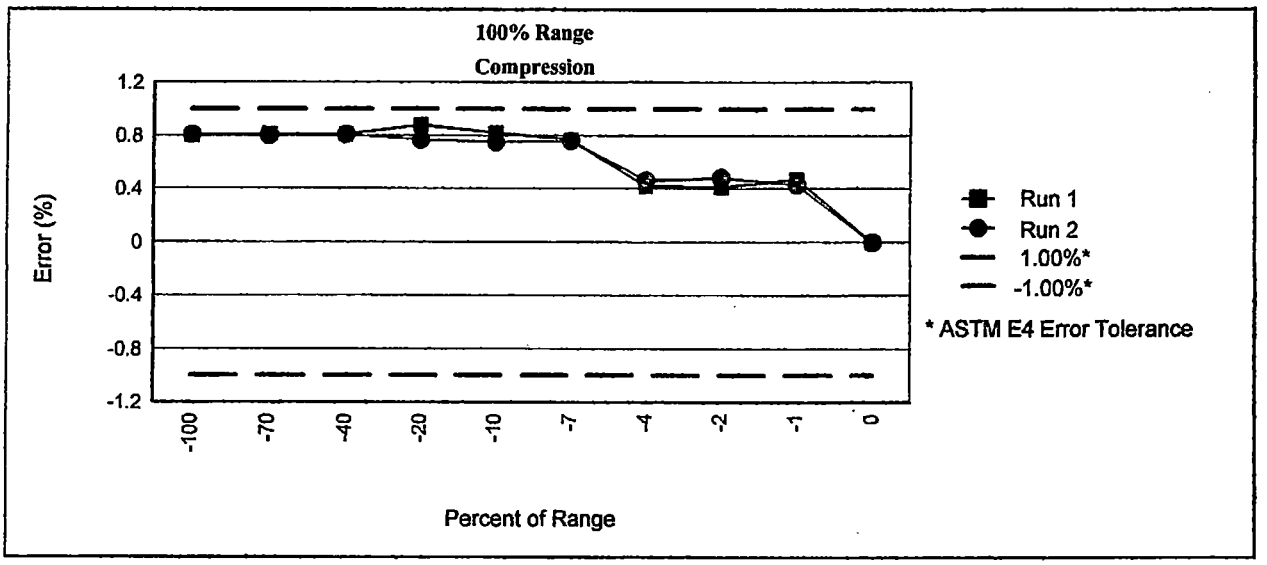
CERTIFICATE OF CALIBRATION

NVLAP ACCREDITED CALIBRATION LABORATORY No. 200301-0

CERTIFICATE NUMBER:
340013012095410

The Return to Zero tolerance is ± the indicator resolution, 0.1 % of the maximum force verified in the range, or 1% of the lowest force verified in the range, whichever is greater.

Graphical Data - Indicator 1 - Digital Readout (lbf)



Verification Equipment

Make/Model	Serial Number	Description	Calibration Agency	Capacity	Cal Date	Cal Due
Extech 445580	1003552	temp. indicator	Tektronix	NA	12-Feb-11	12-Feb-13
HBM ML38	90630412	force indicator	Instron	NA	21-Jan-11	21-Jan-13
Strainsense 050530	050530	load cell	Instron	120000 lbf	10-Dec-10	10-Dec-12
HBM 10KFRR	688077	load cell	Instron	12000 lbf	24-Apr-10	24-Apr-12

Verification Equipment Usage

Range Full Scale (%)	Standard Serial Number	Mode	Percent(s) of Range	Lower Limit for Standard Class A / A1 (lbf)
100	050530	C	7/10/20/40/70/100	5000 / 5000
100	688077	C	1/2/4	200 / 200

Instron standards are traceable to NIST.

The standard Class A lower limit is used for systems with an accuracy of +/- 1.0% and the standard Class A1 lower limit is used for systems with an accuracy of +/- 0.5%.

Standard forces have been temperature compensated as necessary.

Comments

Instron CalproCR Version 3.23

CERTIFICATE OF CALIBRATION

ISSUED BY: INSTRON CALIBRATION LABORATORY

DATE OF ISSUE: 12-Apr-12 CERTIFICATE NUMBER: **516041212091759**

NVLAP

Lab code: 200301-0

Instron
825 University Avenue
Norwood, MA 02062-2643
Telephone: (800) 473-7838
Fax: (781) 575-5750
Email: service_requests@instron.com

APPROVED SIGNATORY

Jimmy Warner

Digitally signed by Jimmy Warner
DN: cn=Jimmy Warner, c=US, l=Norwood, st=MA, ou=OVR
Reason: I attest to the accuracy and integrity of this document
Date: 2012.04.12 09:51:28 -04'00'

Type of Calibration: **Strain**
Relevant Standard: **ASTM E83-10**
Date of Calibration: **12-Apr-12**

Customer Requested Due Date: **23-Mar-13**

Customer

Name: Purdue University
Address: 550 Stadium Mall Drive
Civil Room G151
West Lafayette IN 47907
sarahh@purdue.edu
P.O./Contract No.:
Contact: Kevin Brower

Machine

Manufacturer: BALDWIN
Serial Number: 120BTEC502040
System ID: 120BTEC502040
Range Type: Single

Transducer

Manufacturer: EPSILON
Transducer ID: 3543-0800-200T-ST/E89895
Extensometer Type: Type 1
Travel (Tension): 2 in
Gauge Length: 8 in
Mode: Static (Tension)

Classification

The following indicators of the extensometer system were verified and classed:

Indicator Type	Description	Indicator Units	Range Full Scale (%)	System Class
1. Digital Readout		strain	100	B-1

Certification Statement

All indicators listed above were verified on-site at customer location by Instron in accordance with ASTM E83.

The verification and equipment used conform to a controlled Quality Assurance program which meets the specifications outlined in ANSI/NCSL Z540-1, ISO 10012, ISO 9001:2008 and ISO/IEC 17025:2005.

The testing machine was verified in the 'as found' condition.

Instron Calpro Version 3.23

CERTIFICATE OF CALIBRATION

NVLAP ACCREDITED CALIBRATION LABORATORY No. 200301-0

CERTIFICATE NUMBER:
516041212091759

Summary of Results

Indicator 1. - Digital Readout (strain)

Range Full Scale (%)	Tested Range (in)	Mode	System Class*	Resolution (strain)	Resolution Class	ASTM E83 Lower Limit (in)
100	0.2 to 2	Tension	B-1	0.000001	A	0.0008

** System Class for a range is the worst of the following classes: gauge length class, resolution class, individual point error class, repeatability class and is also based on the measurement capability of the laboratory.*

Gauge Length Measurement and Classification

Nominal Gauge Length (in)	Actual Gauge Length (in)	Measurement Type	Error in Gauge Length (%)	ASTM E83 Gauge Length Class	Uncertainty of Measurement* (in)
8	7.9897	Direct	-0.13	B-1	0.0062

** The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95%.*

Data Summary and Classification

Indicator 1. - Digital Readout (strain)

% of Range	Run 1 Error Fixed (strain)	Run 1 Error Relative (% of strain)	Run 2 Error Fixed (strain)	Run 2 Error Relative (% of strain)	Repeat Error (strain)	Worst Class	Uncertainty of Measurement* (strain)
100% Range (Full Scale: 2 in)							
10	0.00000	0.012	-0.00001	-0.037	0.00001	A	0.000025
20	-0.00003	-0.054	0.00000	-0.004	0.00003	A	0.000042
40	0.00003	0.028	0.00003	0.034	0.00000	A	0.000079
70	0.00001	0.005	0.00005	0.028	0.00004	A	0.000137
100	-0.00016	-0.064	-0.00019	-0.074	0.00003	A	0.000195

** The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95%.*

Data

Indicator 1. - Digital Readout (strain)

% of Range	Run 1 Indicated (strain)	Run 1 Applied (in)	Run 2 Indicated (strain)	Run 2 Applied (in)
100% Range (Full Scale: 2 in)				
	Run Temperature: 73.0 °F		Run Temperature: 73.3 °F	
0	0.000001	0.000000	0.000006	0.000000
10	0.025004	0.200000	0.024998	0.200010
20	0.049975	0.400010	0.050004	0.400000

Instron Calpro Version 3.23

CERTIFICATE OF CALIBRATION

NVLAP ACCREDITED CALIBRATION LABORATORY No. 200301-0

CERTIFICATE NUMBER:
516041212091759

Data

Indicator 1. - Digital Readout (strain)

% of Range	Run 1 Indicated (strain)	Run 1 Applied (in)	Run 2 Indicated (strain)	Run 2 Applied (in)
100% Range (Full Scale: 2 in)				
	Run Temperature: 73.0 °F		Run Temperature: 73.3 °F	
40	0.100030	0.800010	0.100040	0.800000
70	0.175010	1.400000	0.175060	1.400040
100	0.249840	2.000000	0.249820	2.000000

Verification Equipment and Usage

Verification Equipment:

Make/Model	Serial Number	Description	Calibration Agency	Measurement Range	Cal Date	Cal Due
Extech 445580	984437	temp. indicator	Tektronix	NA	28-Dec-11	28-Dec-13
Boeckeler Micrometer 1398	20641 (ASTM)	disp. indicator	A.A. Jansson	2.00 in	07-Oct-11	07-Oct-12
* Fowler Economy Electronic	SH9J2879982	disp. indicator	AA Jansson	NA	20-Apr-10	20-Apr-12

** Equipment used for gauge length measurements.*

Verification Equipment Usage:

Measurement Type	Serial Number	Range (% Full Scale)	Percent(s) of Range
Displacement	20641 (ASTM)	100	0/10/20/40/70/100

Instron standards are traceable to NIST and/or other National standards.

Comments

none

Verified by: James Warner
Field Service Engineer

NOTE: Clause 9 of ASTM E-83 states; It is recommended that extensometer systems be verified annually or more frequently if required. In no case shall the time interval between verifications exceed 18 months (unless an extensometer is being used in a long-time test running beyond the 18 month period). An extensometer system shall not be used after an adjustment or repair that could affect its accuracy without first verifying its accuracy utilizing the procedure described in this practice.

CALIBRATION CERTIFICATE

Address
86 Seabro Avenue
Amityville, NY 11701
Website
www.kessslerusa.com

KESSLER

KESSLER THERMOMETER CORPORATION

Telephone
631-841-5500
Facsimile
631-841-5553
E-mail
KesslerUSA@aol.com

CALIBRATION REPORT FOR THERMOMETER

THIS REPORT OF CALIBRATION SHALL DOCUMENT THAT THE INSTRUMENT DESCRIBED HEREIN WAS EXAMINED AND TESTED IN KESSLER'S CALIBRATION LABORATORY AGAINST NIST TRACEABLE REFERENCE STANDARDS, IN ACCORDANCE TO KESSLER'S PROCEDURE T-2008, WHICH IS BASED ON ASTM E-77-98 (2003) AND NIST PIBLICATION 250-23. THIS CALIBRATION MEETS THE REQUIREMENTS OF ISO/IEC 17025, ANSI/NCLS Z2540-1-1994 AND THE ISO 9000 AND QS 9000 SERIES OF QUALITY STANDARDS.

CUSTOMER INFORMATION: GILSON COMPANY, INC.

Purchase Order Number: PO00096475

Date Calibrated: September 20, 2011 Next Recommended Due Date: October 20, 2012

INSTRUMENT DESCRIPTION:

Serial No.: 689373 Marked: KESSLER USA Catalog No.: 6340-FC

Scale Range: 30/124°F Divisions: 0.2°F Immersion: 3"

RESULTS OF PHYSICAL EXAMINATION:
This instrument was examined under a polarized lens and strains in the glass, if any, were judged to be minimal and of no detriment to the function of the instrument. The capillary was examined under magnification and no irregularities or foreign material was discovered. It was determined that this instrument was suitable for calibration.

RESULTS OF CALIBRATION:

TEST TEMP	READING	CORRECTION	UNCERTAINTY
32.00	32.04	-0.04	+/-0.06
60.00	60.00	0.00	+/-0.06
80.00	80.20	-0.20	+/-0.06
100.00	100.20	-0.20	+/-0.06
120.00	120.20	-0.20	+/-0.06

- The above readings were made under magnification and resolved to one tenth of one scale division.
- The indications of this instrument cannot be adjusted or modified by ordinary means: accordingly, the readings given in the table above should be considered, in effect to be both "As Found" and "As Left" readings
- Laboratory Environment Conditions: Temperature: 25°C ± 5°C / Relative Humidity: Between 40% and 60%
- All temperatures given in this report are based on the International Scale of 1990 (ITS-90)

TRACEABILITY INFORMATION:
NIST Primary Standard: Rosemount Model 162CE Serial No. 5058
Transfer Standard: Hart Scientific 1502A Serial No. A14422 / 547027

Calibration Performed By: Barbara Plaza

Approved By: John Lewis

Calibration Report Prepared By: RP

Report No.: 092011-03

CALIBRATION REPORT

PI TAPE®

Report Number:	02221223040412
Date Issued:	Apr-04-12
Pi Tape Corporation Serial Number:	02221223
Tape Size:	2" – 12" O.D.

About this Calibration

Temperature	68 Degrees F ± 2 Degrees	
Relative Humidity	45% ± 15%	
Tension	Five Pounds	
Tape Tolerance	Within .001"	Within Mfg Tolerance of .001"
Uncertainty of Measurement	±.00025 Inches	

Calibration Performed by: Jerry Mathis

Actual Findings and Procedure Numbers

Tape Reads	4.9000	Over 4.9000"	Procedure 1

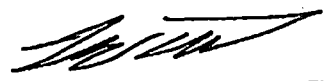
Remarks: New Gage

Calibration Equipment Used

Gage	Serial Number	Test Date	Due Date	NIST Traceable Report Number
4.9"	102098	May-12-11	May-12-12	86903-1

This tape has been checked at one or more points over a calibrated measuring standard. Calibration performed in accordance with ANSI/NCSL Z540-1-1994, ISO/IEC 17025 and the former MIL-STD 45662A.

All standards are traceable to the National Institute of Standards and Technology



Jerry Mathis, Quality Assurance Manager

Pi Tape Corporation
344 N. Vinewood St. Escondido, CA 92029 USA
Phone (760) 746-9830 Fax (760) 746-9196
www.pitape.com

TRIMOS

CERTIFICAT D'ETALONNAGE		***Date***	
KALIBRIER-ZERTIFIKAT	***N° 26594***	***Datum***	***13.10.2009***
CALIBRATION CERTIFICATE		***Date***	

Objet Gegenstand Object	Instrument vertical Vertikal- Messgerät Vertical instrument
Type Typ Model	V1004+
Numéro de série Serien-Nummer Serial number	10473 / A
Date d'émission du certificat Ausgabedatum des Zertifikates Certificate issue date	13.10.2009

Déclaration de confirmité

L'instrument de mesure auquel se réfère ce certificat a été réalisé conformément aux données techniques de TRIMOS contenues dans les documents de vente (prospectus, manuels d'utilisation).

Konformitätserklärung

Das Messgerät, auf welches sich dieses Zertifikat bezieht, wurde entsprechend den von TRIMOS in den Verkaufs-unterlagen (Prospekte, Gebrauchsanleitung) angegebenen technischen Daten hergestellt.

Conformity declaration

The measuring instrument to which this certificate refers to has been manufactured in acordance with the given TRIMOS specifications stated in sale documents (leaflets, instructions for use).

Responsable département qualité: Leiter der Qualitätsabteilung: Manager of quality department:	Gilbert Villard	Contrôleur: Prüfer: Inspector:	Philippe Desponds

TRIMOS SA | Av. de Longemalle 5 | CH-1020 Renens | Switzerland
☎ ++41 21 633 01 01 | 🖷 ++41 21 633 01 02 | office@trimos.ch | http://www.trimos.ch

TRIMOS

CERTIFICAT D'ETALONNAGE		***Date***	
KALIBRIER-ZERTIFIKAT	***N° 26594***	***Datum***	***13.10.2009***
CALIBRATION CERTIFICATE		***Date***	

Caractéristique de l'objet mesuré
Merkmale des Gegenstander der Kalibrierung
Features of the calibrated object

Nombre d'axes de mesures Anzahl der Messachsen Number of measuring axis	1
Etendue de mesure Messbereich Measuring range	0 - 990 mm 0 - 38.976 in
Coefficient de dilatation linéaire Linearer Ausdehnungskoeffizient Linear expansion coefficient	11.5 µm/m

Etalonnage
Kalibrierung
Calibration

Accessoire(s) utilisé(s) Verwendete Zubehöre Used accessories	V-1
Pas de mesure Messstufen Measuring steps	20 mm (.787 in)
Nombre de série de mesures Anzahl von Messreihen Number of measurement series	3
Principe de mesure Messprinzip Principle of measurement	En montant Antastung aufwärts Upwards direction

Condition de référence
Referenzbedingungen
Reference conditions

Températures / Temperatur / Temperature	20°C +/- 0.5°C
Humidité relative / Relative Luftfeuchtigkeit / Relativ humidity	50% +/- 5%
Pression d'air / Luftdruck / Air pressure	722 mm Hg

TRIMOS SA Av. de Longemalle 5 CH-1020 Renens Switzerland
☎ ++41 21 633 01 01 🖷 ++41 21 633 01 02 REDACTED VERSION office@trimos.ch http://www.trimos.ch

TRIMOS

CERTIFICAT D'ETALONNAGE ***N° 26594*** ***Date***
KALIBRIER-ZERTIFIKAT ***Datum*** ***13.10.2009***
CALIBRATION CERTIFICATE ***Date***

Etalon de référence et traçabilité
Bezugsnormal und Rückverfolgbarkeit
Reference standard and tracability

Les résultats de mesure contenus dans ce certificat d'étalonnage se réfèrent, par une traçabilité documentée, aux étalons reconnus sur le plan national et dont la conformité avec le système international d'unité (SI) est démontrée. L'étalon de référence est composé des éléments suivants :

Die in diesem Kalibrierzertifikat erhaltenen Ergebnisse von Messungen sind über Bezugsnormale bsw. Einrichtungen auf national Normale rückverfolgbar. Deren Übereinstimmung ist durch das Internationale Einheitensystem (SI) nachgewiesen. Das Bezugsnormal besteht aus folgenden Elementen :

All measurement results contained in this calibration certificate maintain a link of tracability recognized by national standards. Their accordance with the international unity system (SI) is proved. The reference standard is composed of the following components:

Etalon de référence **Bezugsnormal** **Reference standard**	**N° de série** **Serien-Nr.** **Serial no.**	**N° du certificat** **Zertifikat-Nr.** **Certificate no.**	**Etalonné par** **Kalibriert durch** **Calibrated by**
Check-Master	800002	81228	Fabricant
Equerre	215-904	E310Z106	Kunz SCS
Marbre 2000x1800	1644	R402B028	Kunz SCS

* Métrologie et accréditation suisse

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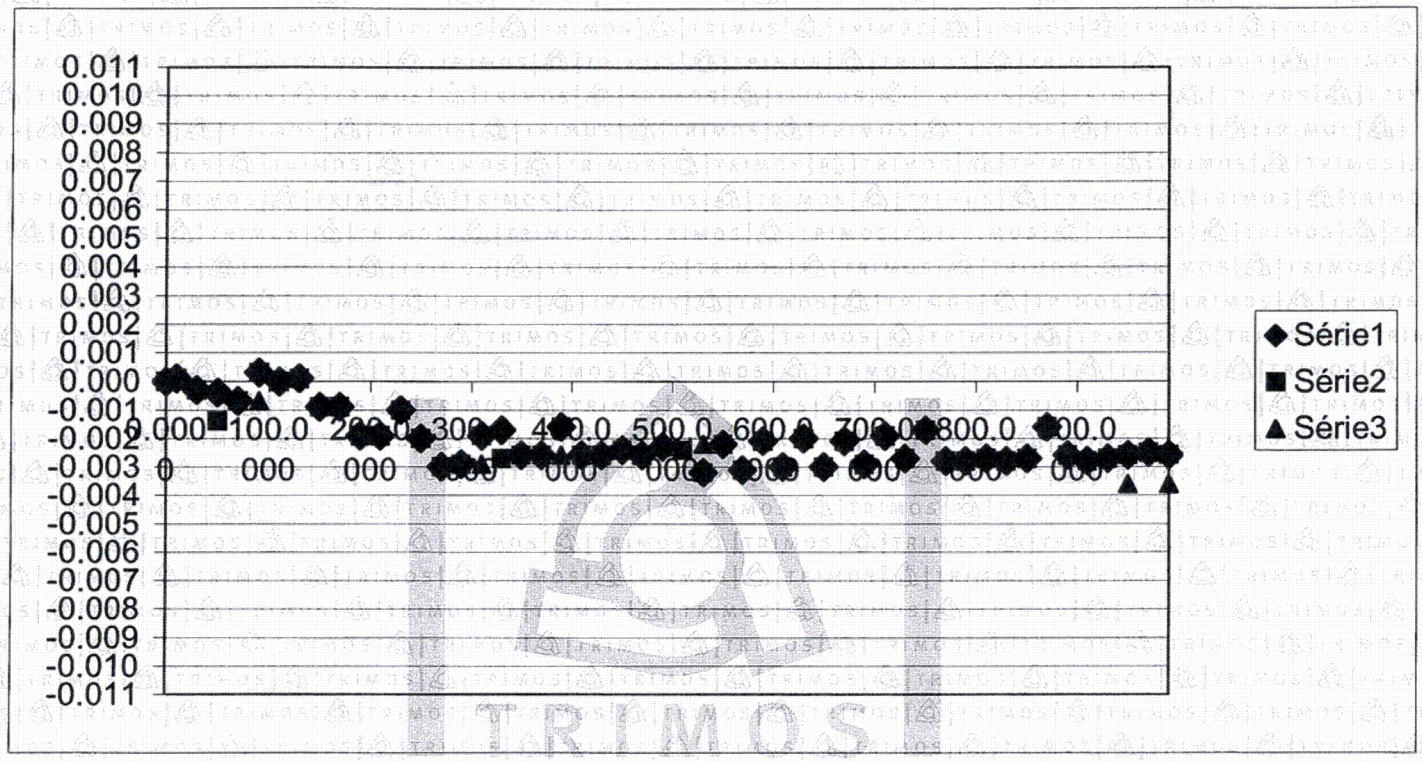
CALIBRATION CERTIFICATE ***Date***

Justesse
Richtigkeit
Freedom from bias



Valeur réelle Wahrer Wert True value mm	Série 1 Serie 1 Series 1 mm	Série 2 Serie 2 Series 2 mm	Série 3 Serie 3 Series 3 mm	Moyenne Mittenwert Average mm	Ecart moyen Mittenabweichung Average deviation µm
0.0000	0.000	0.000	0.000	0.000	**0.0**
9.9999	10.000	10.000	10.000	10.000	**0.1**
30.0003	30.000	30.000	30.000	30.000	**-0.3**
50.0004	50.000	49.999	49.999	49.999	**-1.1**
70.0007	70.000	70.000	70.000	70.000	**-0.7**
90.0007	90.001	90.001	90.000	90.001	**0.0**
110.001	110.001	110.001	110.001	110.001	**0.0**
130.0009	130.001	130.001	130.001	130.001	**0.1**
150.0009	150.000	150.000	150.000	150.000	**-0.9**
170.0009	170.000	170.000	170.000	170.000	**-0.9**
190.0009	189.999	189.999	189.999	189.999	**-1.9**

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CALIBRATION CERTIFICATE **Date**

Valeur vraie Wahrer Wert True value mm	Série 1 Serie 1 Series 1 mm	Série 2 Serie 2 Series 2 mm	Série 3 Serie 3 Series 3 mm	Moyenne Mittenwert Average mm	Ecart moyen Mittenabweichung Average deviation µm
210.0009	209.999	209.999	209.999	209.999	-1.90
230.001	230.000	230.000	230.000	230.000	-1.00
250.001	249.999	249.999	249.999	249.999	-2.00
270.001	269.998	269.998	269.998	269.998	-3.00
290.0009	289.998	289.998	289.998	289.998	-2.90
310.0009	309.999	309.999	309.998	309.999	-2.23
330.0007	329.999	329.998	329.998	329.998	-2.37
350.0006	349.998	349.998	349.998	349.998	-2.60
370.0006	369.998	369.998	369.998	369.998	-2.60
390.0006	389.999	389.999	389.998	389.999	-1.93
410.0006	409.998	409.998	409.998	409.998	-2.60
430.0006	429.998	429.998	429.998	429.998	-2.60
450.0004	449.998	449.998	449.998	449.998	-2.40
470.0006	469.998	469.998	469.998	469.998	-2.60
490.0003	489.998	489.998	489.998	489.998	-2.30
510.0004	509.998	509.998	509.998	509.998	-2.40
530.0002	529.997	529.997	529.998	529.997	-2.87
550.0002	549.998	549.998	549.998	549.998	-2.20
570.0001	569.997	569.997	569.997	569.997	-3.10
590.0001	589.998	589.998	589.998	589.998	-2.10
610	609.997	609.997	609.997	609.997	-3.00
630	629.998	629.998	629.998	629.998	-2.00
650	649.997	649.997	649.997	649.997	-3.00
670.0001	669.998	669.998	669.998	669.998	-2.10
689.9999	689.997	689.997	689.997	689.997	-2.90
709.9999	709.998	709.998	709.998	709.998	-1.90
729.9997	729.997	729.997	729.997	729.997	-2.70
749.9997	749.998	749.998	749.998	749.998	-1.70
769.9998	769.997	769.997	769.997	769.997	-2.80
789.9998	789.997	789.997	789.997	789.997	-2.80
809.9997	809.997	809.997	809.997	809.997	-2.70
829.9998	829.997	829.997	829.997	829.997	-2.80
849.9997	849.997	849.997	849.997	849.997	-2.70
869.9996	869.998	869.998	869.998	869.998	-1.60
889.9996	889.997	889.997	889.997	889.997	-2.60
909.9998	909.997	909.997	909.997	909.997	-2.80
929.9997	929.997	929.997	929.997	929.997	-2.70
949.9996	949.997	949.997	949.996	949.997	-2.93
969.9995	969.997	969.997	969.997	969.997	-2.50
989.9996	989.997	989.997	989.996	989.997	-2.93

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KALIBRIER-ZERTIFIKAT ***N° 26594*** ***Datum*** ***13.10.2009***
CALIBRATION CERTIFICATE ***Date***

Résultas de mesure
Messergebnisse
Measurement results

Erreur maximale autorisée Max. Fehlergrenze Maximum permissible error	5.8 µm
Erreur maximale mesurée Grösste gemessene Abweichung Maximum error measured	3.2 µm
Fidélité Wiederholpräzision Repeatability	+/- 2s < 2 µm

Incertitude de mesure
Messunsicherheit
Uncertainty of measurement

L'incertitude de mesure "U" indiquée ci-après pour la détermination des erreurs de mesures englobe : l'objet étalonné, l'étalon de référence, l'étendue de mesure et les conditions de référence.

Die nachstehend angegebene Messunsicherheit "U" für die Ermittlung der Messabweichungen umfasst folgende Komponente: das kalibrierte Objekt, das Bezugsnormal, den Messbereich und die Referenzbedingungen.

The uncertainty of measurement "U" for the determination of the errors of measurement given hereafter includes the calibrated object, the reference standard, the measuring range and the reference conditions.

le niveau de confiance est de 95% Das Vertrauensniveau beträgt 95% Confidence probability is 95%	**K** = 2
Incertitude de mesure Messunsicherheit Uncertainty of measurement	**U** 95 = 2.5µm + (L(mm) / 300)

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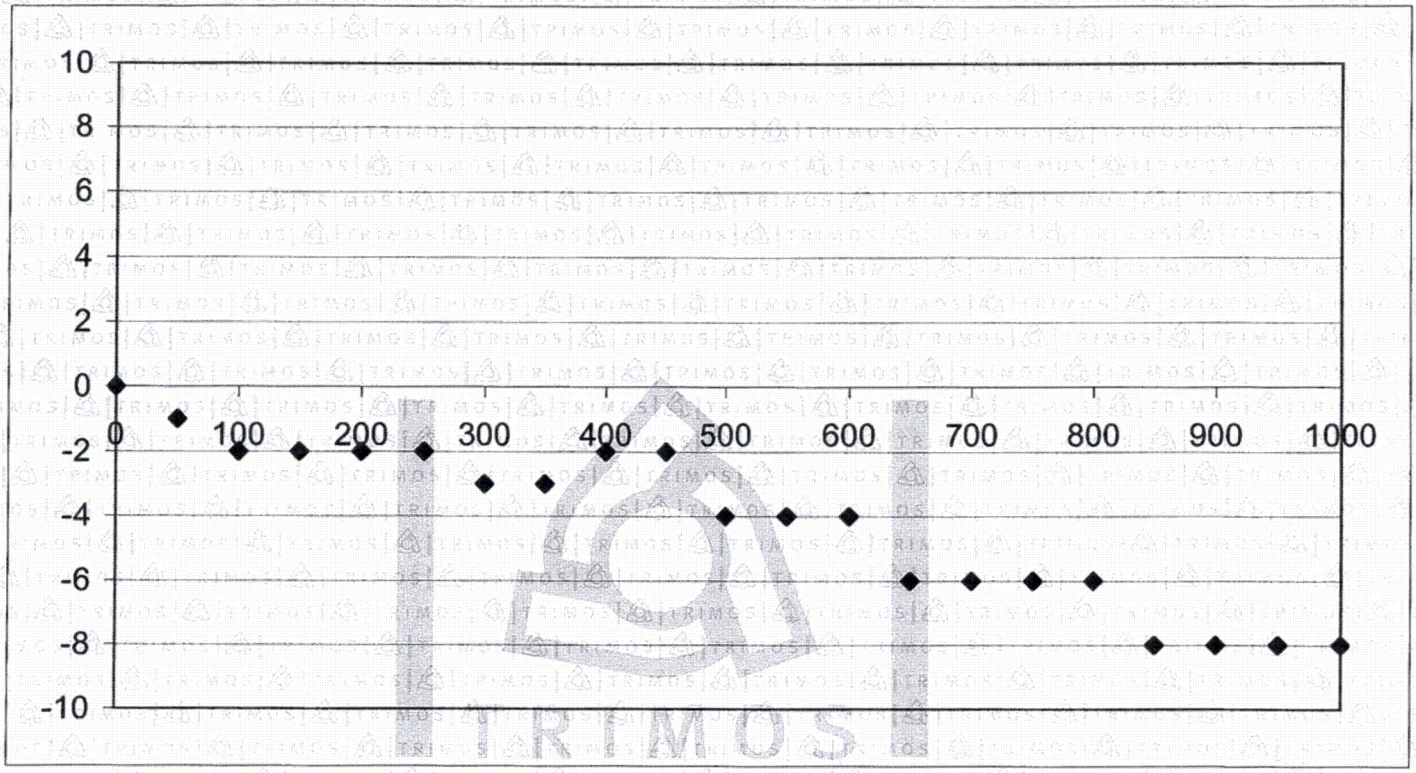
Côntrole de la perpendicularité (direction de mesure)
Kontrolle der Rechtwinkligkeit (Messrichtung)
Checking of the squareness (measuring direction)



Hauteur Höhe Height **mm**	Ecart Abweichung Deviation **µm**
0	0.0
50	-1.0
100	-2.0
150	-2.0
200	-2.0
250	-2.0
300	-3.0
350	-3.0
400	-2.0
450	-2.0
500	-4.0

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KALIBRIER-ZERTIFIKAT ***Datum*** ***13.10.2009***
CALIBRATION CERTIFICATE ***Date***

Hauteur Höhe Height **mm**	Ecart Abweichung Deviation **µm**
550	-4.0
600	-4.0
650	-6.0
700	-6.0
750	-6.0
800	-6.0
850	-8.0
900	-8.0
950	-8.0
1000	-8.0

Resultats du contrôle de la perpendicularité (dans la direction de mesure) :
Ergebnisse der Rechtwinkligkeitsprüfung (in Messrichtung) :
Resullts of squareness checking (in measuring direction) :

Erreur maximale autorisée
Max. angegebene Fehlergrenze 12.0 µm
Maximum permissible error

Erreur de la perpendicularité mesurée 8.0 µm
Gemessene Rechtwinkligkeitsabweichung
Squareness error measured

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NVLAP Accredited by the National Voluntary Laboratory Accreditation Program for the specific scope of accreditation under Lab Code 105013

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Weight

Certificate Number 663364-1
Date of Calibration 30-APR-2012

SECTION 1: NAME AND ADDRESS OF CUSTOMER

End user
Purdue University
1040 S. River Road
Bowen Laboratory
West Lafayette IN 47907

Client
Precision Weighing Balances
30 South Cross Road
Bradford MA 01835-8232

SECTION 2: APPROVED SIGNATORY

Joseph Moran, Metrology Manager

SECTION 3: PERSON PERFORMING WORK

Daniel Foglio

SECTION 4: CERTIFICATE INFORMATION

Description of Masses: Grip Handle

Accuracy Class	: NIST 105-1 Class F	Date Received	: 30-APR-2012
Order Number	: 100001369	Date of Calibration	: 30-APR-2012
Construction	: Two Piece	Date of Issue	: 30-APR-2012
Material	: Cast Iron	Weight Range	: 100 lb

SECTION 5: ENVIRONMENTAL CONDITIONS DURING TEST

Temperature: 21.84°C Pressure: 769.06 mm Hg Relative Humidity: 48%

SECTION 6: PERTINENT INFORMATION

The Weights listed on this calibration report have been compared to reference mass standards that are directly traceable to the National Institute of Standards and Technology under Test No. 822-275872-11.

Reference standards and balances used to perform the calibration are listed in Section 10.

The weights calibrated for this report have been calibrated in accordance with Troemner's calibration process. The calibration performed meets Level III criteria as described in the NIST/NVLAP Technical Guide 150-2.

This calibration also meets specifications as outlined in ISO 9001, ISO/IEC 17025, ANSI/NCSL Z540-1-1994, NRC Document 10CFR50 Appendix B, and applicable documents.

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SECTION 7: TRUE MASS (MASS IN VACUUM) CALIBRATION DATA

Nominal Mass Value	Serial Number	True Mass	Density[1] of Weight	Uncertainty (+ or -)
100 lb		45362.709 g	7.2000 g/cm^3	450 mg

1 Density is assumed unless otherwise stated

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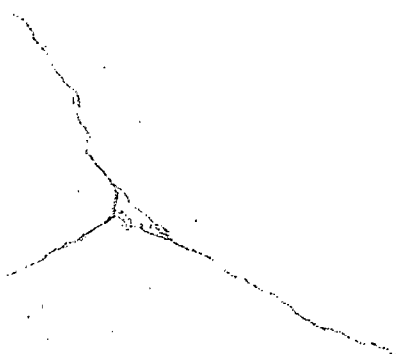
SECTION 8: MASS IN AIR CALIBRATION VALUE VS. REFERENCE DENSITY 8000 kg m^{-3}

Nominal Mass Value	Serial Number	Conventional Mass Value	Uncertainty (+ or -)	Tolerance (+ or -)
100 lb		45361.953 g	450 mg	4.5000 g



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SECTION 9: MASS IN AIR CALIBRATION DATA VS. REFERENCE DENSITY 8000 kg m^{-3}

Nominal Mass Value	Serial Number	Conventional Mass Correction	Uncertainty (+ or -)	Tolerance (+ or -)
100 lb		2716 mg	450 mg	4.5000 g

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Weight

Certificate Number 663364-1
Date of Calibration 30-APR-2012

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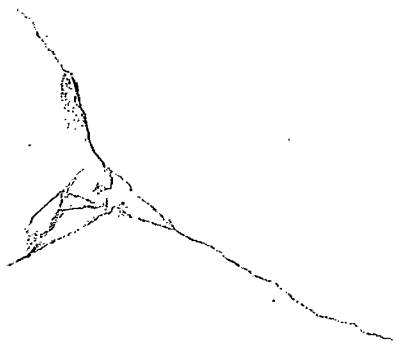
SECTION 10: CALIBRATION PROCEDURE DATA

Nominal Mass Value	Serial Number	Standard Set No.	Cal Due	Balance Used	Cal Due	Procedure Used
100 lb		S1104	05/31/12	XP64003L-A01	11/30/12	Multi A-B



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Weight

Certificate Number 663364-1

Date Of Calibration 30-APR-2012

NAME AND ADDRESS OF CUSTOMER

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SECTION 11: GENERAL INFORMATION

This calibration was performed in Troemner's High Precision Level I Mass Metrology Laboratory at 201 Wolf Drive, Thorofare, New Jersey 08086 unless otherwise noted on page one. The internal procedures used are CAL-CLASSI and NIST HB145.

SECTION 12: DEFINITIONS AND TERMS

MASS IN A VACUUM - The mass of a weight as if it were measured in a vacuum. Also known as True Mass.

MASS IN AIR - The conventional value of the result of weighing in air, in accordance to International Recommendation OIML D 28. For a weight taken at 20° C, the conventional mass is the mass of a reference weight of a density of 8000 $kg \cdot m^{-3}$ which it balances in air of a density of 1.2 $kg \cdot m^{-3}$.

AS FOUND MASS IN A VACUUM - The measured value of the mass(es) as they were received by Troemner.

AS LEFT MASS IN A VACUUM - The measured value of the mass(es) after they were adjusted, repaired or replaced when necessary. The As Found Mass in a Vacuum will equal the As Left Mass in a Vacuum if the mass(es) did not require adjustment, repair or replacement.

NOMINAL MASS - The mass value as marked on the weight.

CORRECTION - The difference between the mass value of a weight and its nominal value. A positive correction indicates that the mass value is greater than the nominal value by the amount of the correction.

AS FOUND CONVENTIONAL MASS CORRECTION - The conventional correction of the result, as it was received by Troemner, of weighing in air in accordance to International Recommendation D 28. For a weight taken at 20° C, the conventional mass is the mass of a reference weight of density 8000 $kg \cdot m^{-3}$ which it balances in air density of 1.2 $kg \cdot m^{-3}$. If the customer requires cleaning prior to calibration, the after cleaning correction would be reported.

AS LEFT CONVENTIONAL MASS CORRECTION - The conventional correction of the result, after adjustment repair, or replacement of weighing in air in accordance to International Recommendation D 28. For a weight taken at 20° C, the conventional mass is the mass of a reference weight of density 8000 $kg \cdot m^{-3}$ which it balances in air density of 1.2 $kg \cdot m^{-3}$. The As Found will equal the As Left Conventional Mass Correction if the mass(es) did not require adjustment, repair or replacement.

(continued on next page)

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Weight

Certificate Number 663364-1

Date of Calibration 30-APR-2012

NAME AND ADDRESS OF CUSTOMER

End user
Purdue University
1040 S. River Road
Bowen Laboratory
West Lafayette IN 47907

Client
Precision Weighing Balances
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SECTION 12: DEFINITIONS AND TERMS (continued)

UNCERTAINTY - The standard deviation associated with the result of the measurement that characterizes the dispersion of the values that could reasonably be attributed to the measurand. The uncertainty is calculated in accordance with NIST TechNote 1297 / UKAS M3003 using a coverage factor of $k = 2$ ($k = 2$ defines an interval having a level of confidence of approximately 95 percent). The uncertainty does not include possible effects of magnetism.

TOLERANCE - Defines the limits in which the correction value and the uncertainty must fall to meet the tolerance specification for the given Class.

AS FOUND CONVENTIONAL MASS VALUE - The measured value of the mass(es) as they were received by Troemner, of weighing in air in accordance to International Recommendation OIML D 28. For a weight taken at 20° C, the conventional mass is the mass of a reference weight of density 8000 $kg \cdot m^{-3}$ which it balances in air density of 1.2 $kg \cdot m^{-3}$. If the customer requires cleaning prior to calibration, the after cleaning value would be reported. F denotes Out of Tolerance Weight.

AS LEFT CONVENTIONAL MASS VALUE - The measured value of the mass(es) after they were adjusted, repaired or replaced when necessary, of weighing in air in accordance to International Recommendation OIML D 28. For a weight taken at 20° C, the Conventional Mass is the mass of a reference weight of density 8000 $kg \cdot m^{-3}$ which it balances in air density of 1.2 $kg \cdot m^{-3}$. The As Found will equal the As Left Conventional Mass Value if the mass(es) did not require adjustment, repair or replacement.

ASTM E617-97 - Weights meet the tolerance specification for ASTM E617-97. Weights 2kg - 1g screened for magnetism using a Gaussmeter.

Project: Tests to Determine the Behavior of Spliced #11 Bars | Calibration Documentation v.1 (Rev. 04/02/2012) | Bowen Lab - Purdue University

Calibration Instrument Name and S.N.:	Instron 1044172
Data Acquisition System:	OptroTrack Pro Series 600
Gain:	NA
Excitation Voltage:	NA
Channel:	NA
Sensor:	OptroTrack Pro Series 600
Sensor S.N.:	OptroTrack Pro Series 600

Input [in.]	Output [in.]		Input [in.]	Output [in.]	
0	0		6.5	6.507	
0	0		6.5	6.507	
1	1.001		4	3.999	
1	1.001		4	3.999	
4	3.998		1.5	1.499	
4	3.997		1.5	1.498	
6.5	6.502				
6.5	6.502				
9	9.007				
9	9.007				

Operator	Signature	Date	Time
S.P.	A. Dujol	6/13/12	10 AM
Checked by	Signature	Date	Time
BPR	Thomas Ritz	6/13/12	10:15 AM
Checked by	Signature	Date	Time

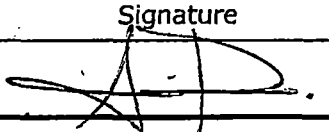
Results	Sensitivity	Accuracy
	1	0.007 in.

Notes: The accuracy of the INSTRON sensor is 0.003 in.

Project: Tests to Determine the Behavior of Spliced #11 Bars | Calibration Documentation v.1 (Rev. 04/02/2012) | Bowen Lab - Purdue University Sheet 1 of 1

Calibration Instrument Name and S.N.:	INSTRON 1044172
Data Acquisition System:	NI- SCXI-1000 PCI 6289
Gain:	1
Excitation Voltage:	3.333
Channel:	MI-0
Sensor:	PA-20-NJC-DS-L3M
Sensor S.N.:	37100980

Measurand	Voltage	Measurand	Voltage	Measurand	Voltage
~~0.611~~	~~1.498~~				
0.611	0.038				
2.602	0.362				
4.553	0.675				
6.560	1.001				
8.630	1.332				

Operator	Signature	Date	Time
S.P.		5/9/12	
Checked by	**Signature**	**Date**	**Time**
BPR		5/9/12	
Checked by	**Signature**	**Date**	**Time**

Results	Sensitivity	Accuracy
	6.197 in/V	0.1 %

Notes:

Project: Tests to Determine the Behavior of Spliced #11 Bars

Calibration Documentation v.1 (Rev. 04/02/2012)

Bowen Lab - Purdue University

Calibration Instrument Name and S.N.:	INSTRON 1044-172
Data Acquisition System:	NI-SCXI-1000 PCI 6289
Gain:	1
Excitation Voltage:	3.333
Channel:	MI-1
Sensor:	PA-20-NJC-DS-L3M
Sensor S.N.:	37100981

Measurand	Voltage	Measurand	Voltage	Measurand	Voltage
8.630	1.335				
6.618	1.011				
4.640	0.691				
2.655	0.369				
0.651	0.041				

Operator	Signature	Date	Time
S.P.		5/9/12	
Checked by	Signature	Date	Time
BPR		5/9/12	
Checked by	Signature	Date	Time

Results	Sensitivity	Accuracy
	6.167 in/V	0.1%

Notes:

Project: Tests to Determine the Behavior of Spliced #11 Bars

Calibration Documentation v.1 (Rev. 04/02/2012)

Bowen Lab - Purdue University

Calibration Instrument Name and S.N.:	INSTRON 1044172
Data Acquisition System:	NI SCXI-1000 PCI 6289
Gain:	1
Excitation Voltage:	3.333
Channel:	M1-02
Sensor:	PA-10-DS
Sensor S.N.:	40010980

Measurand	Voltage	Measurand	Voltage	Measurand	Voltage
8.594	2.578				
6.647	1.965				
4.600	1.323				
2.603	0.696				
0.642	0.071				

Operator	Signature	Date	Time
S.P.		5/9/12	
Checked by	Signature	Date	Time
BPR		5/9/12	
Checked by	Signature	Date	Time

Results	Sensitivity	Accuracy
	3.175 in/V	0.2%

Notes:

REDACTED VERSION

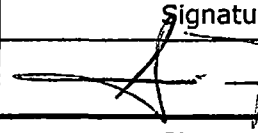
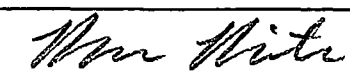
Project: Tests to Determine the Behavior of Spliced #11 Bars

Calibration Documentation v.1 (Rev. 04/02/2012)

Bowen Lab - Purdue University

Calibration Instrument Name and S.N.:	INSTRON 1044172
Data Acquisition System:	NI SCXI-1000 PCI 6289
Gain:	1
Excitation Voltage:	3.333
Channel:	M1-03
Sensor:	PA-10-DS
Sensor S.N.:	40010985

Measurand	Voltage	Measurand	Voltage	Measurand	Voltage
0.610	0.056				
2.578	0.682				
4.625	1.328				
6.566	1.939				
8.620	2.584				

Operator	Signature	Date	Time
S. P.		5/9/12	
Checked by	**Signature**	**Date**	**Time**
BPR		5/9/12	
Checked by	**Signature**	**Date**	**Time**

Results	Sensitivity	Accuracy
	3.169 in/V	0.2%

Notes:

Project: Tests to Determine the Behavior of Spliced #11 Bars

Calibration Documentation v.1 (Rev. 04/02/2012)

Bowen Lab - Purdue University

Calibration Instrument Name and S.N.:	INSTRON 1044172
Data Acquisition System:	NI SCXI-1000 PCI 6289
Gain:	1
Excitation Voltage:	3.333
Channel:	M2-O
Sensor:	PA-10-DS
Sensor S.N.:	40010977

Measurand	Voltage	Measurand	Voltage	Measurand	Voltage
8.620	2.590				
6.602	1.957				
4.607	1.331				
2.604	0.699				
0.611	0.065				

Operator	Signature	Date	Time
S.P.		5/9/12	
Checked by	Signature	Date	Time
BPR		5/9/12	
Checked by	Signature	Date	Time

Results	Sensitivity	Accuracy
	3.173 in/V	0.2%

Notes: M2-O

REDACTED VERSION

Project: Tests to Determine the Behavior of Spliced #11 Bars

Calibration Documentation v.1 (Rev. 04/02/2012)

Bowen Lab - Purdue University

Calibration Instrument Name and S.N.:	Instron 1094172
Data Acquisition System:	NI - SCXI - 1000 PCI 6289
Gain:	100
Excitation Voltage:	10V
Channel:	M2-02
Sensor:	3175 - 50K
Sensor S.N.:	443

Measurand	Voltage	Measurand	Voltage	Measurand	Voltage
0	0				
6.1	-0.00240				
11.9	-0.00466				
15.3	-0.00600				
20.2	-0.00790				
25.3	-0.00990				
30.4	-0.01190				

Operator	Signature	Date	Time
S.P.		5/9/12	
Checked by	Signature	Date	Time
BPR		5/9/12	
Checked by	Signature	Date	Time

Results	Sensitivity	Accuracy
	-2556 K/V	0.1%

Notes:

Project: Tests to Determine the Behavior of Spliced #11 Bars

Calibration Documentation v.1 (Rev. 04/02/2012)

Bowen Lab - Purdue University

Calibration Instrument Name and S.N.:	Instron 1044172
Data Acquisition System:	NI - SCXI - 1000 PCI 6289
Gain:	100
Excitation Voltage:	10V
Channel:	M2-3
Sensor:	3175-50K
Sensor S.N.:	442

Measurand	Voltage	Measurand	Voltage	Measurand	Voltage
0	0				
5.5	-0.00215				
10.4	-0.00407				
15.5	-0.00605				
20.5	-0.00799				
25.5	-0.00996				
30.5	-0.01190				
0	+0.000010				

Operator	Signature	Date	Time
S.P.		5/9/12	
Checked by	Signature	Date	Time
BPR		5/9/12	
Checked by	Signature	Date	Time

Results	Sensitivity	Accuracy
	-2563 K/V	0.1%

Notes:

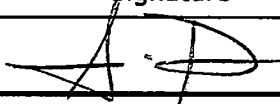
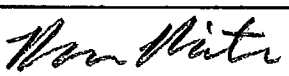
Project: Tests to Determine the Behavior of Spliced #11 Bars

Calibration Documentation v.1 (Rev. 04/02/2012)

Bowen Lab - Purdue University

Calibration Instrument Name and S.N.:	INSTRON 1044172
Data Acquisition System:	NI SCXI-1000 PCI 6289
Gain:	1
Excitation Voltage:	30
Channel:	M3-0
Sensor:	LUCAS DCEC-2000
Sensor S.N.:	J7250

Measurand	Voltage	Measurand	Voltage	Measurand	Voltage
1.835	-4.272				
1.500	-2.655				
1.000	-0.253				
0.500	2.133				
0.125	3.953				

Operator	Signature	Date	Time
S.P.		5/9/12	
Checked by	**Signature**	**Date**	**Time**
BPR		5/9/12	
Checked by	**Signature**	**Date**	**Time**

Results	Sensitivity	Accuracy
	-0.208 in/V	0.1%

Notes:

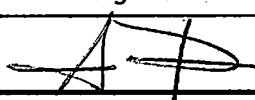
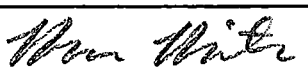
Project: Tests to Determine the Behavior of Spliced #11 Bars

Calibration Documentation v.1 (Rev. 04/02/2012)

Bowen Lab - Purdue University

Calibration Instrument Name and S.N.:	INSTRON 1044172
Data Acquisition System:	NI SCXI-1000 PCI 6289
Gain:	1
Excitation Voltage:	30
Channel:	M3-1
Sensor:	LUCAS DCEC-2000
Sensor S.N.:	J7251

Measurand	Voltage	Measurand	Voltage	Measurand	Voltage
0.125	4.150				
0.507	2.318				
0.999	-0.020				
1.500	-2.414				
1.835	-4.025				

Operator	Signature	Date	Time
S.P.		5/9/12	
Checked by	Signature	Date	Time
BPR		5/9/12	
Checked by	Signature	Date	Time

Results	Sensitivity	Accuracy
	-0.209 in/V	0.1%

Notes:

Calibration Instrument Name and S.N.:	INSTRON PUID 1044172
Data Acquisition System:	NI SCXI 1000 SN 1188607
Gain:	1
Excitation Voltage:	3.333V
Channel:	M1-Ø
Sensor:	PA-20
Sensor S.N.:	37100980

Measurand	Voltage	Measurand	Voltage	Measurand	Voltage
0.5"	0.307				
2.5"	0.627				
4.5"	0.952				
6.5"	1.271				
8.5"	1.594				

Operator	Signature	Date	Time
S.P.	[signature]	6/13/12	3 PM
Checked by	Signature	Date	Time
BPR	[signature]	6/13	3:10PM
Checked by	Signature	Date	Time

Results	Sensitivity	Accuracy
	0.0483 V/V/in	0.1%

Notes: Deviation from sensitivity computed before test*: 0.3% ✓ ok

* 0.0484 V/V/in.

Project: Tests to Determine the Behavior of Spliced #11 Bars

Calibration Documentation v.1 (Rev. 04/02/2012)

Bowen Lab - Purdue University

Calibration Instrument Name and S.N.:	INSTRON 1044172
Data Acquisition System:	NI SCXI 1000 SN 1188607
Gain:	1
Excitation Voltage:	3.333V
Channel:	M1-1
Sensor:	PA-20
Sensor S.N.:	37100981

Measurand	Voltage	Measurand	Voltage	Measurand	Voltage
8.5"	1.612				
6.5	1.291				
4.5	0.968				
2.5	0.646				
0.5	0.320				

Operator	Signature	Date	Time
S.P.		6/13/12	3:20 P.
Checked by	Signature	Date	Time
BPR		6/13	3:30PM
Checked by	Signature	Date	Time

Results	Sensitivity	Accuracy
	0.0484	0.1%

Notes: Deviation = 0.4%

Project: Tests to Determine the Behavior of Spliced #11 Bars

Calibration Documentation v.1 (Rev. 04/02/2012)

Bowen Lab - Purdue University

Calibration Instrument Name and S.N.:	INSTRON 1044172
Data Acquisition System:	NI SCXI 1000 1188607
Gain:	1
Excitation Voltage:	3.333V
Channel:	MI-2
Sensor:	PA-10
Sensor S.N.:	40010980

Measurand	Voltage	Measurand	Voltage	Measurand	Voltage
0.5"	0.584				
2.5	1.212				
4.5	1.839				
6.5	2.467				
8.0	2.942				

Operator	Signature	Date	Time
S.P.		6/13/12	3:30 P.
Checked by	Signature	Date	Time
BPR		6/13	3:40PM
Checked by	Signature	Date	Time

Results	Sensitivity	Accuracy
	0.0943 V/V/in	0.1%

Notes: Deviation : 0.2%

Project: Tests to Determine the Behavior of Spliced #11 Bars | Calibration Documentation v.1 (Rev. 04/02/2012) | Bowen Lab - Purdue University | Sheet 1 of 1

Calibration Instrument Name and S.N.:	INSTRON 1044172
Data Acquisition System:	SCXI 1000 1188607
Gain:	1
Excitation Voltage:	3.333 V
Channel:	M1-3
Sensor:	PA-10
Sensor S.N.:	40010985

Measurand	Voltage	Measurand	Voltage	Measurand	Voltage
8 "	2.934				
6.5	2.462				
4.5	1.835				
2.5	1.207				
0.5	0.577				

Operator	Signature	Date	Time
S.P.	[signature]	6/13/12	3:40 P.
Checked by	Signature	Date	Time
BPR	[signature]	6/13	3:50PM
Checked by	Signature	Date	Time

Results	Sensitivity	Accuracy
	0.0943 V/V/in	0.03%

Notes:
Deviation: 0.4%

Project: Tests to Determine the Behavior of Spliced #11 Bars

Calibration Documentation v.1 (Rev. 04/02/2012)

Bowen Lab - Purdue University

Calibration Instrument Name and S.N.:	INSTRON 1044172
Data Acquisition System:	NI SCXI 1000 1188607
Gain:	1
Excitation Voltage:	3.333V
Channel:	M2-0
Sensor:	PA-10
Sensor S.N.:	40010977

Measurand	Voltage	Measurand	Voltage	Measurand	Voltage
0.5"	0.584				
2.5"	1.215				
4.5"	1.841				
6.5"	2.469				
8.0"	2.939				

Operator	Signature	Date	Time
S.P.	A. Dwyd	6/13/12	3:55 P.
Checked by	Signature	Date	Time
BPR		6/13/12	4:00PM
Checked by	Signature	Date	Time

Results	Sensitivity	Accuracy
	0.0942 V/V/in	0.1%

Notes: Deviation = 0.4%

Project: Tests to Determine the Behavior of Spliced #11 Bars

Calibration Documentation v.1 (Rev. 04/02/2012)

Bowen Lab - Purdue University

Calibration Instrument Name and S.N.:	INSTRON 1044172
Data Acquisition System:	NI SCXI 1000 1188607
Gain:	100
Excitation Voltage:	10V
Channel:	M2-2
Sensor:	LEBOW 50K -443
Sensor S.N.:	443

Measurand	Voltage	Measurand	Voltage	Measurand	Voltage
-0.4+0.4=0	0				
5k +0.4	-0.00211				
10k+0.4	-0.00410				
14.6k+0.4	-0.00588				
19.7k+0.4	-0.00787				
24.7k+0.4	-0.00984				
29.7k+0.4	-0.01178				

Operator	Signature	Date	Time
S.P.	A Dwyd	6/13/12	4:45P
Checked by	Signature	Date	Time
BPR		6/13	4:50PM
Checked by	Signature	Date	Time

Results	Sensitivity	Accuracy
	-1.957 mV/V @FSV	0.1%

Notes: DEVIATION from prev. cal (5/4/12): 0.1%

REDACTED VERSION

Project: Tests to Determine the Behavior of Spliced #11 Bars

Calibration Documentation v.1 (Rev. 04/02/2012)

Calibration Instrument Name and S.N.:	INSTRON 1044172
Data Acquisition System:	NI SCXI 1000 1188607
Gain:	100
Excitation Voltage:	10V
Channel:	M2-3
Sensor:	LEBOW 50k - 442
Sensor S.N.:	442

Measurand	Voltage	Measurand	Voltage	Measurand	Voltage
-0.4 + 0.4k	0.00001				
4.65k + 0.4	-0.00196				
9.67k + 0.4	-0.00392				
14.6k + 0.4	-0.00584				
19.7k + 0.4	-0.00785				
25.25k + 0.4	-0.01001				
29.6k + 0.4	-0.01172				

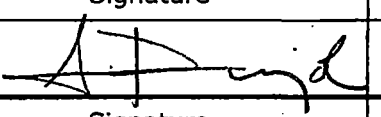
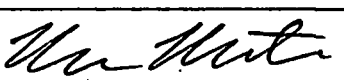
Operator	Signature	Date	Time
S.P.		6/13/12	5:05 P.
Checked by	Signature	Date	Time
BPR		6/13	5:10PM
Checked by	Signature	Date	Time

Results	Sensitivity	Accuracy
	-1.955 mV/V @ 50k	0.1%

Notes: Deviation : 0.2%

Calibration Instrument Name and S.N.:	INSTRON 1044172
Data Acquisition System:	NI SCXI 1000 1188607
Gain:	1
Excitation Voltage:	30V
Channel:	M3-0
Sensor:	LUCAS DCDT ±2"
Sensor S.N.:	J7250

Measurand	Voltage	Measurand	Voltage	Measurand	Voltage
0.125"	4.288				
0.5"	2.477				
1.0"	0.106 ✓				
1.5"	-2.271 ✓				
2.0"	-4.663				
1.0	0.112				
0.5"	2.480				
0.125"	4.289				

Operator	Signature	Date	Time
S.P.		6/13/12	5:50 P
Checked by	**Signature**	**Date**	**Time**
BPR		6/13	6:00PM
Checked by	**Signature**	**Date**	**Time**

Results	Sensitivity	Accuracy
	-4.769 V/in	0.2%

Notes: Deviation from 5/4/12 cal. = 0.7%

Project: Tests to Determine the Behavior of Spliced #11 Bars

Calibration Documentation v.1 (Rev. 04/02/2012)

Bowen Lab - Purdue University

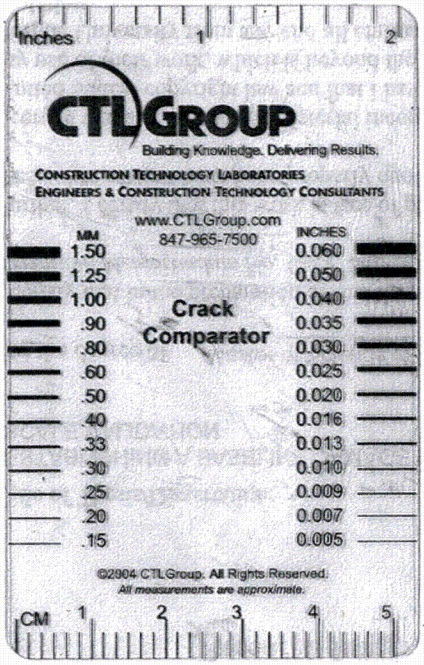
Calibration Instrument Name and S.N.:	INSTRON 1044172
Data Acquisition System:	NISCXI 1000 1188607
Gain:	1
Excitation Voltage:	30V
Channel:	M3-1
Sensor:	LUCAS DOT ±2"
Sensor S.N.:	J7251

Measurand	Voltage	Measurand	Voltage	Measurand	Voltage
0.125"	4.293				
0.500"	2.496				
1.0"	0.140				
1.5"	-2.232				
2.0"	-4.606				

Operator	Signature	Date	Time
S.P.		6/13/12	6PM
Checked by	Signature	Date	Time
BPR		6/13	6:10PM
Checked by	Signature	Date	Time

Results	Sensitivity	Accuracy
	-4.742 V/in	0.2%

Notes: Deviation = 0.7%.


Inches
1
2
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1.50 0.060
1.25 0.050
1.00 0.040
.90 0.035
.80 0.030
.60 0.025
.50 0.020
.40 0.016
.33 0.013
.30 0.010
.25 0.009
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.15 0.005
Crack Comparator
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CM
1
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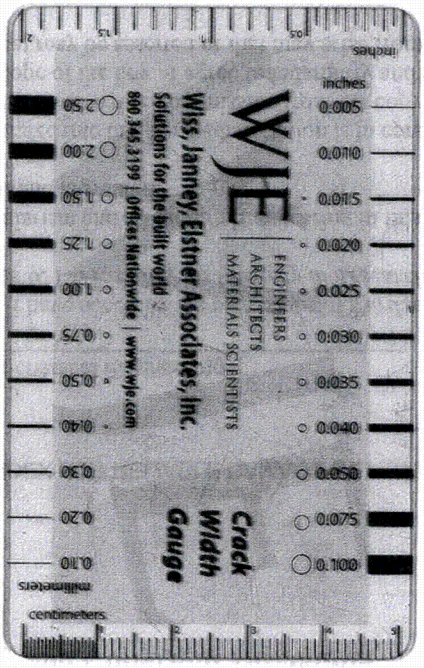
5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2.50
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1.50
1.25
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0.75
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0.40
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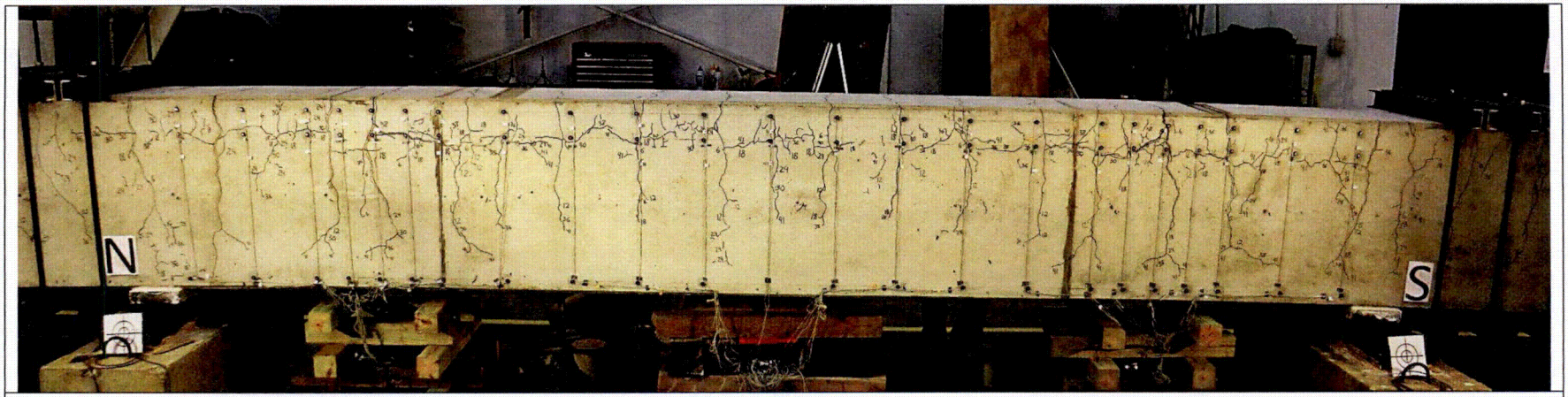
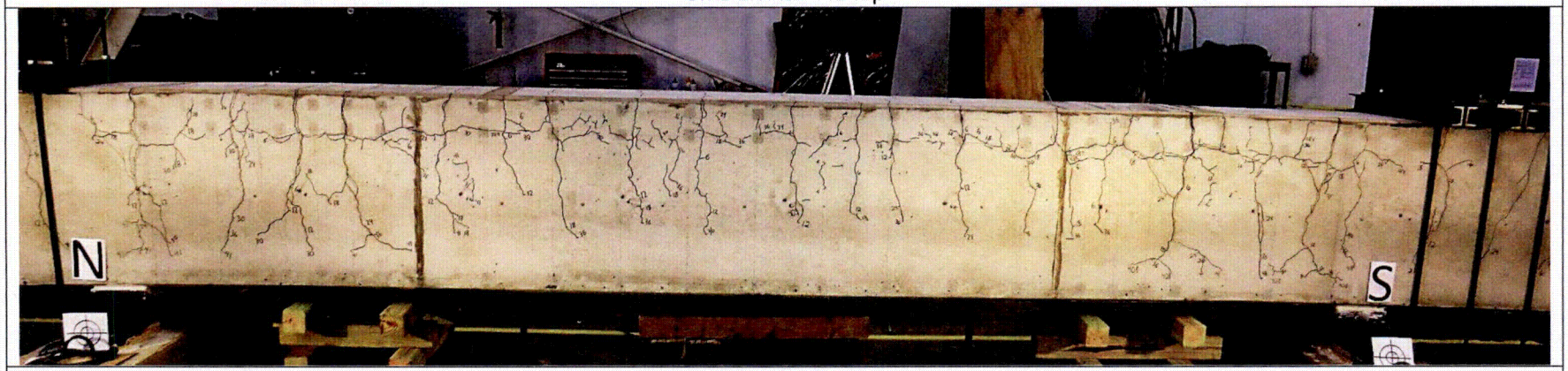


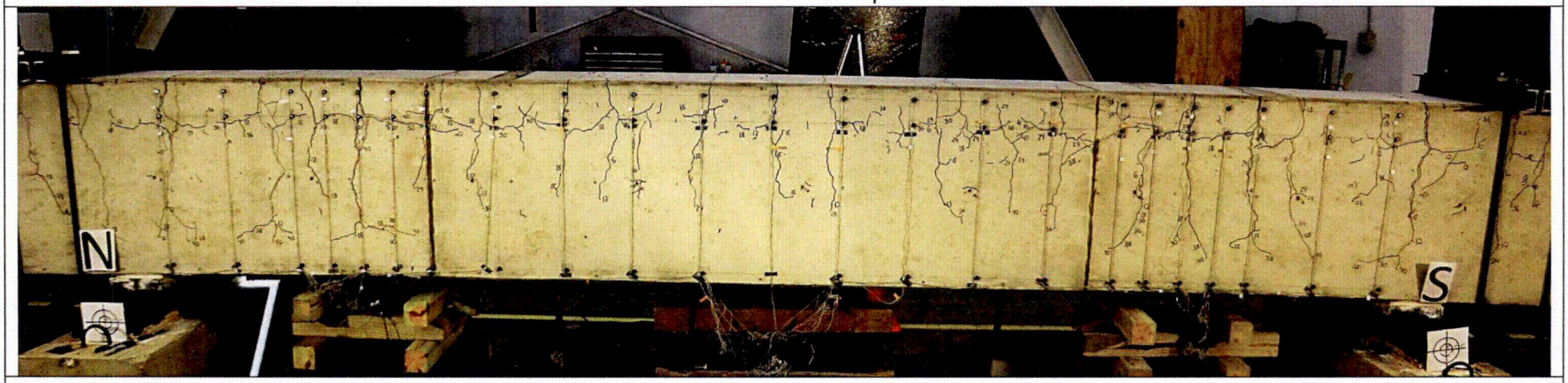
GIRDER A1 – 41 kip



GIRDER A2 – 41 kip

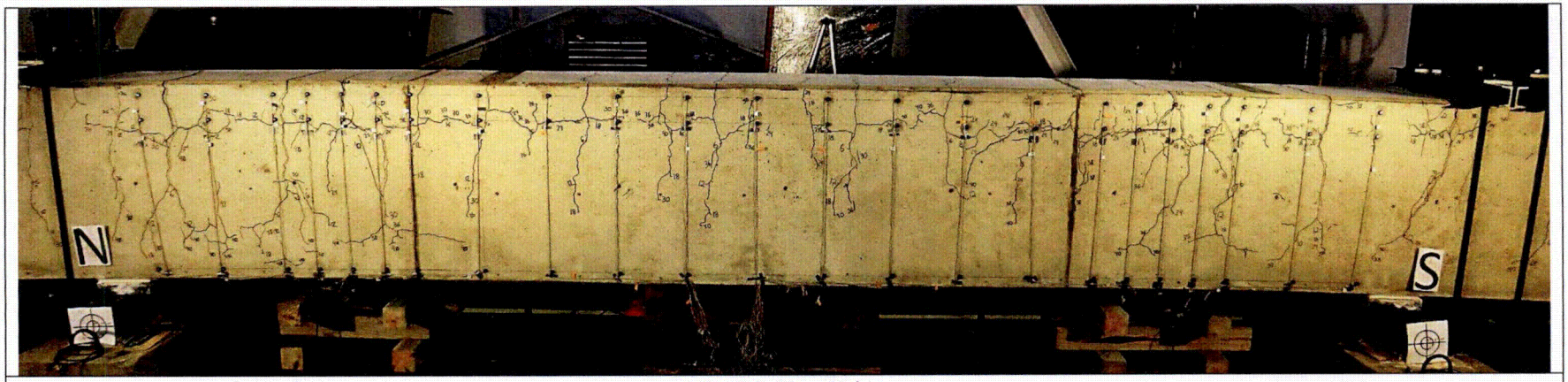
FIRST LOADING

GIRDER A3 – 36 kip

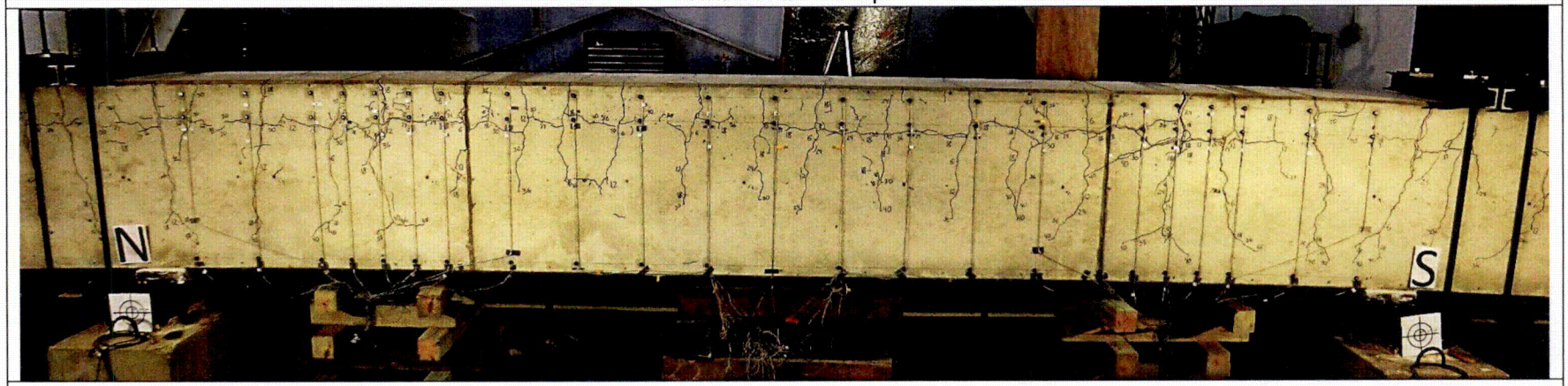


GIRDER A4 – 40 kip

FIRST LOADING



GIRDER A5 – 40 kip



GIRDER A6 – 40 kip

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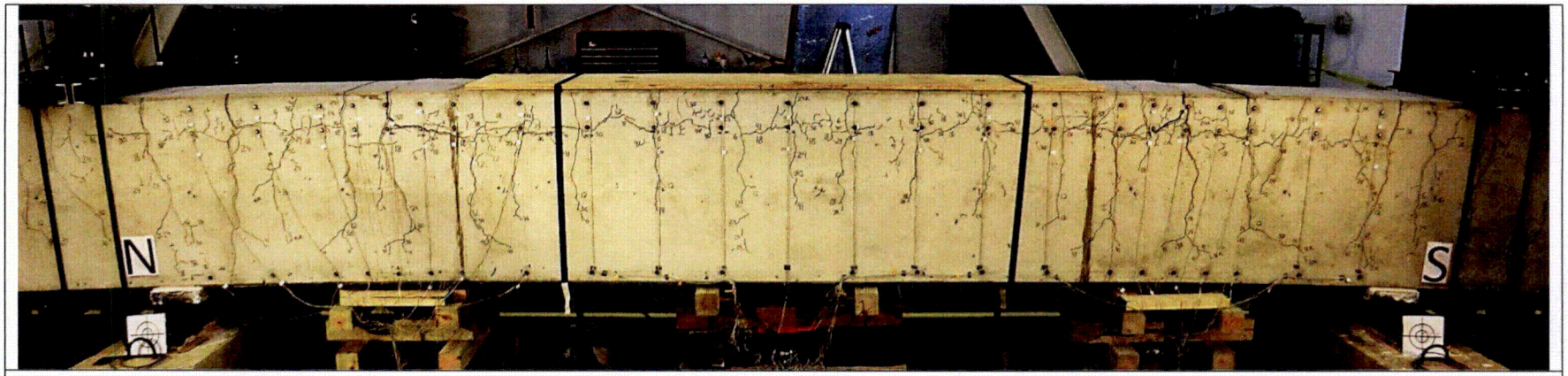


GIRDER A1 – 42 kip

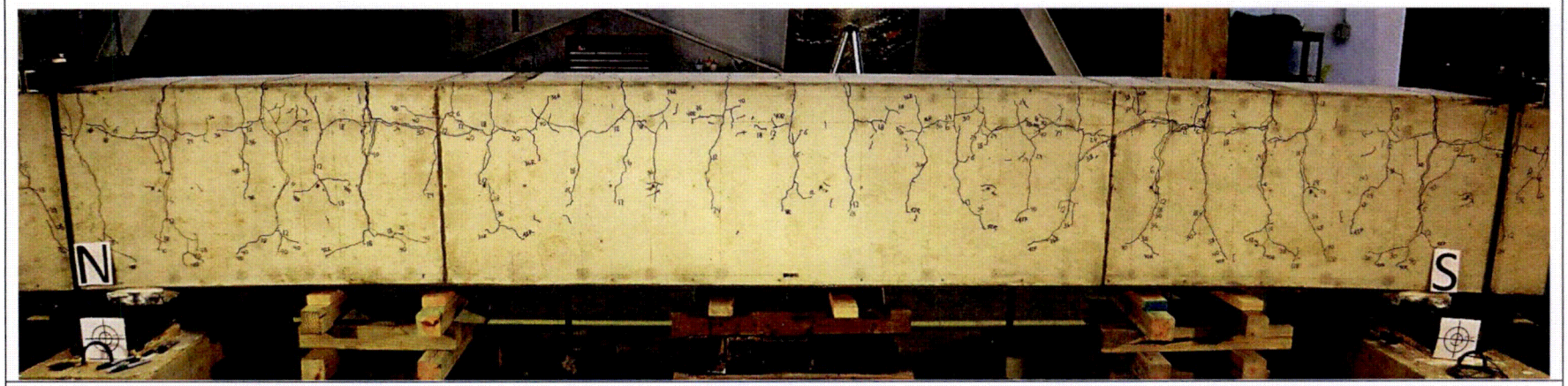
No reload

GIRDER A2

RELOADING

No reload

GIRDER A3



GIRDER A4 – 42 kip

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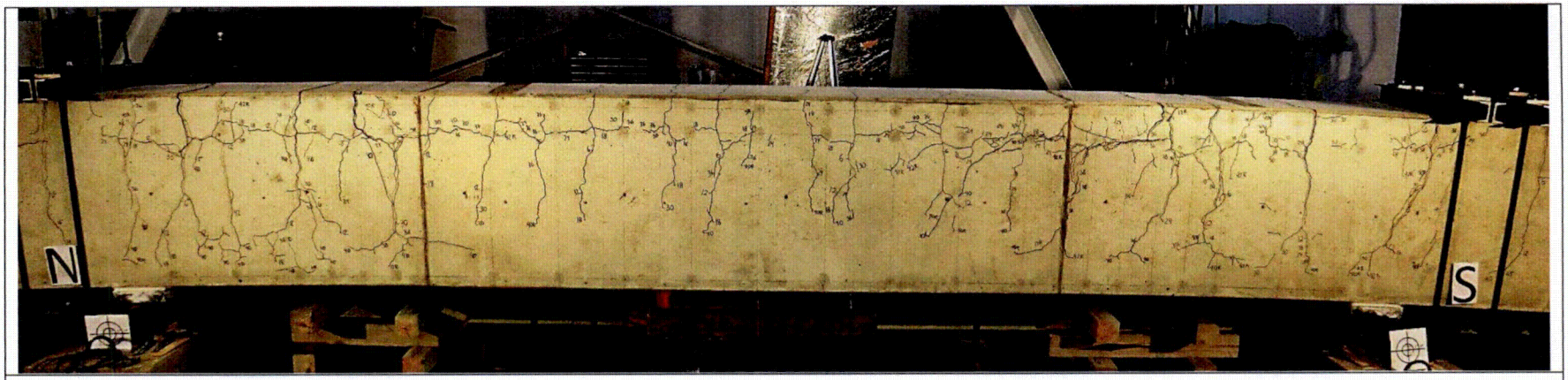
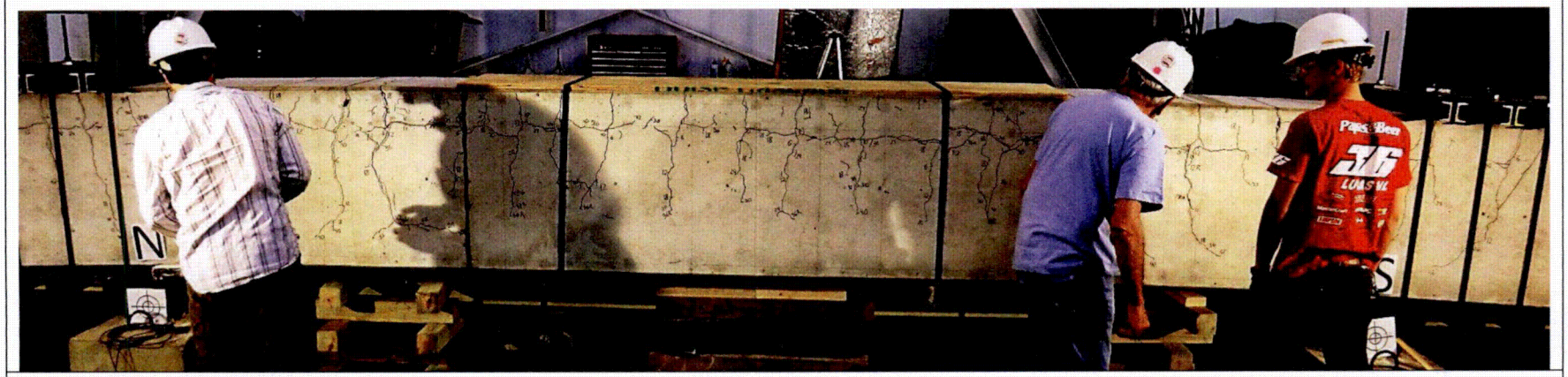
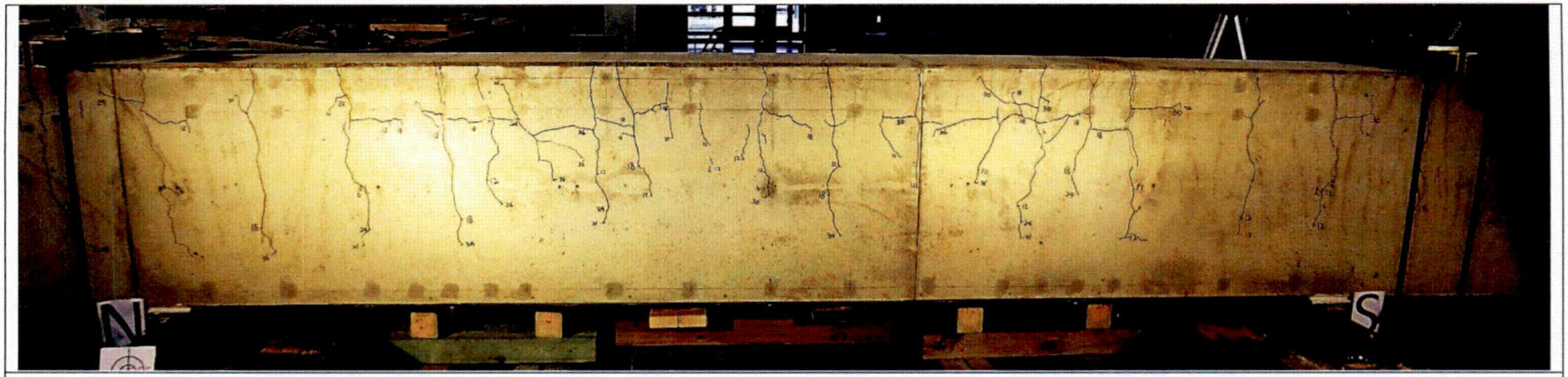


GIRDER A5 – 42 kip

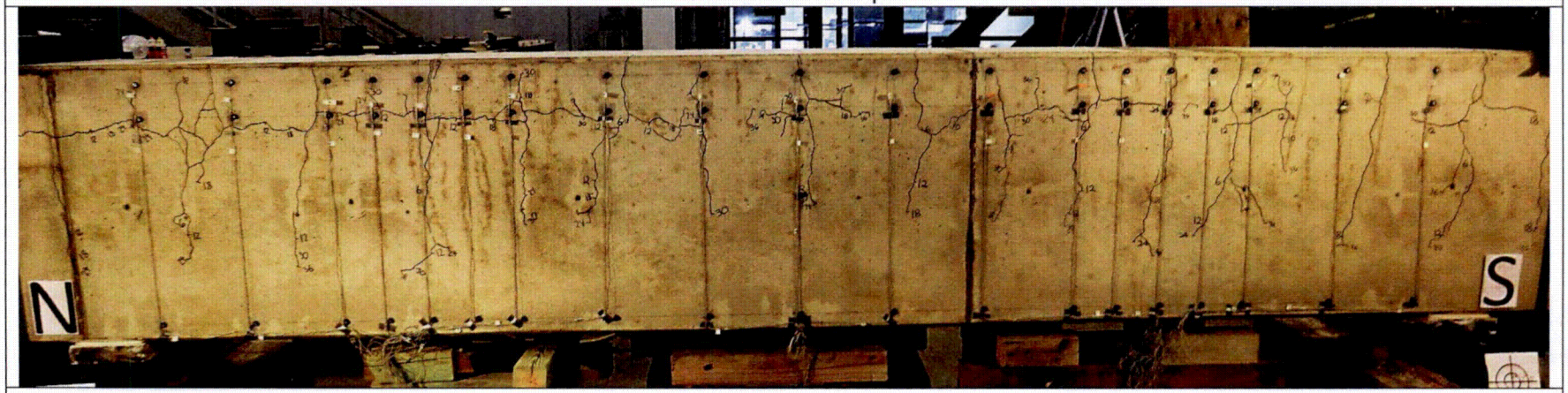


GIRDER A6 – 41 kip

FIRST LOADING

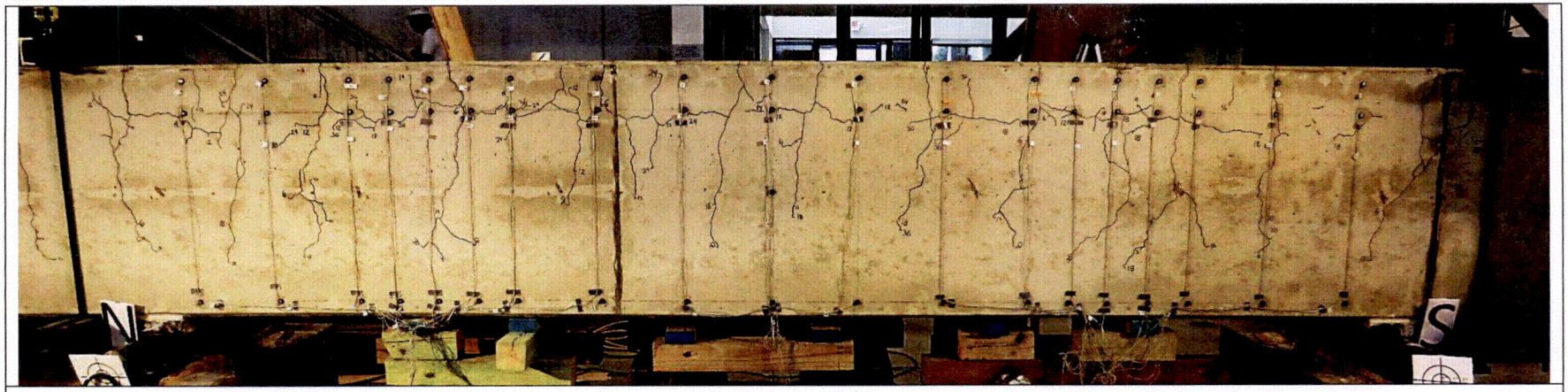


GIRDER B1 – 36 kip

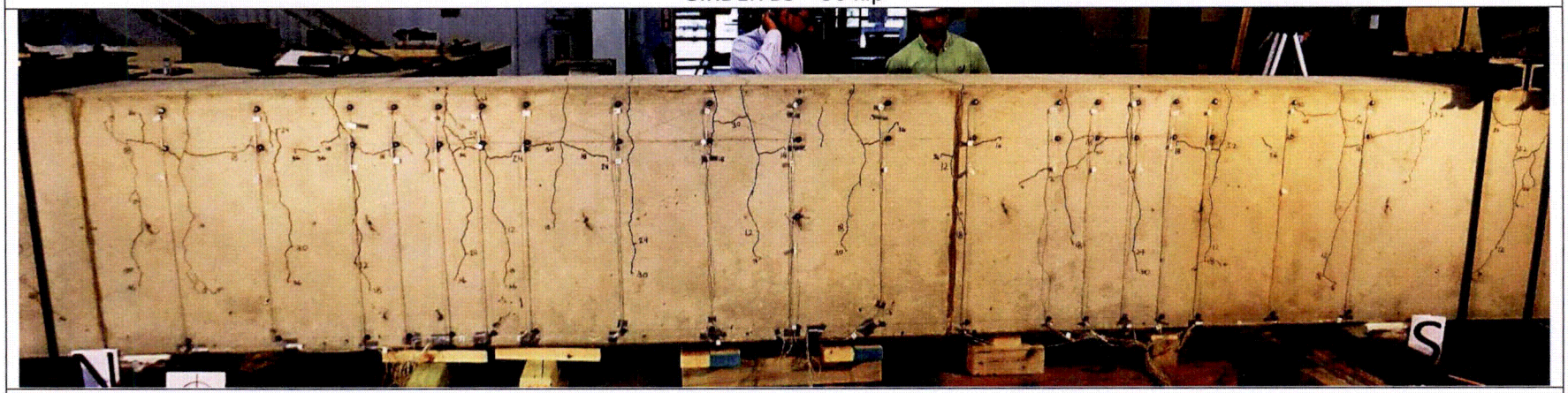


GIRDER B2 – 36 kip

FIRST LOADING

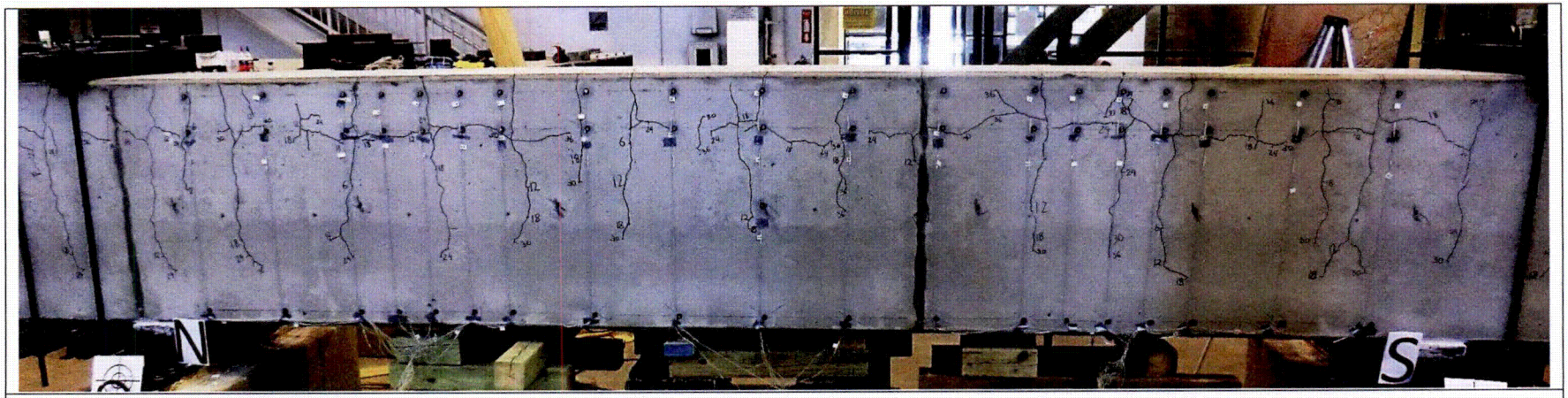


GIRDER B3 – 36 kip

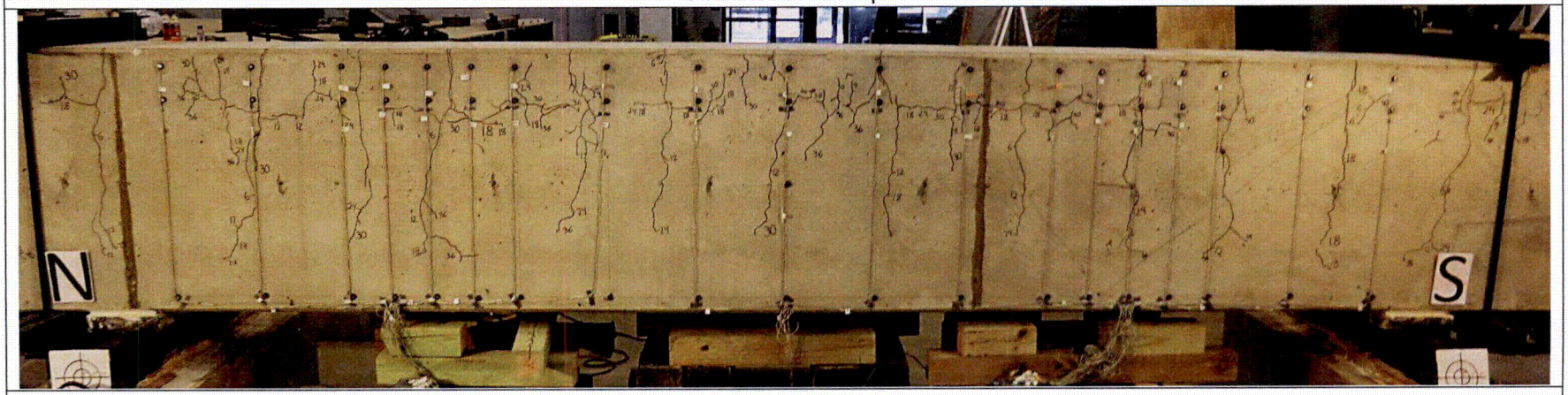


GIRDER B4 – 36 kip

FIRST LOADING



GIRDER B5 – 36 kip



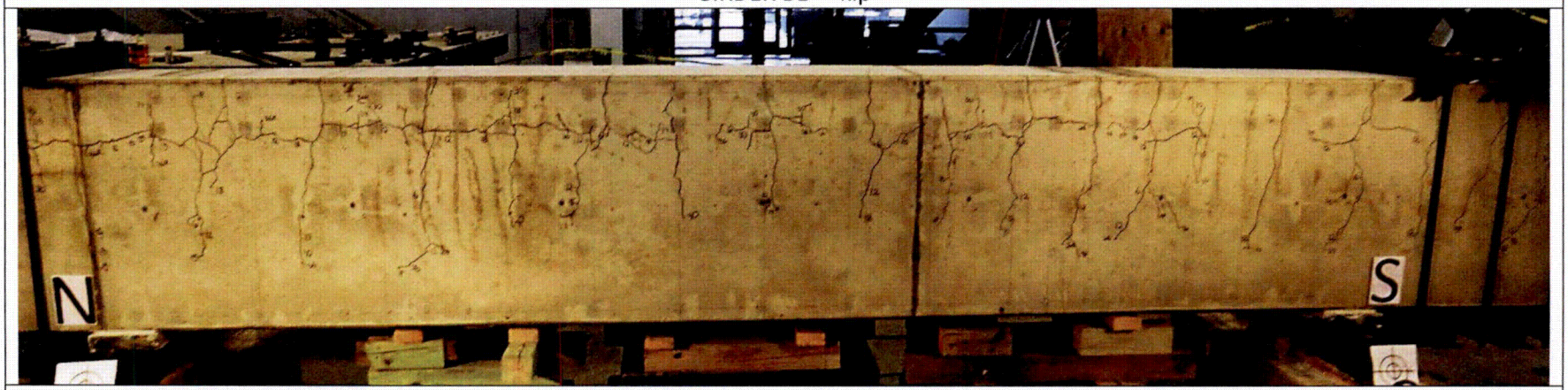
GIRDER B6 – kip

REDACTED VERSION

RELOADING

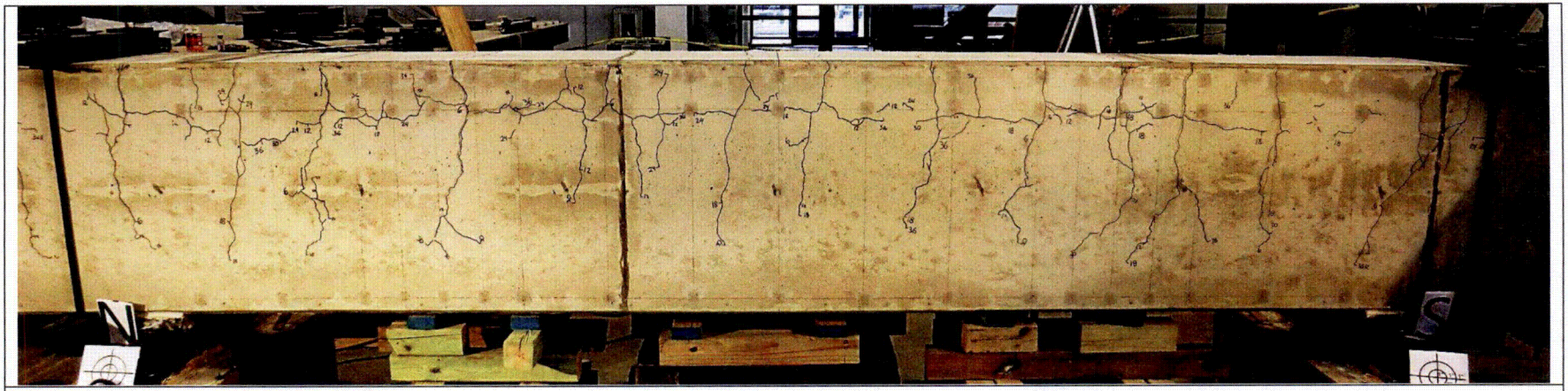
No reload

GIRDER B1 – kip



GIRDER B2 – Load = 36 kip.

RELOADING



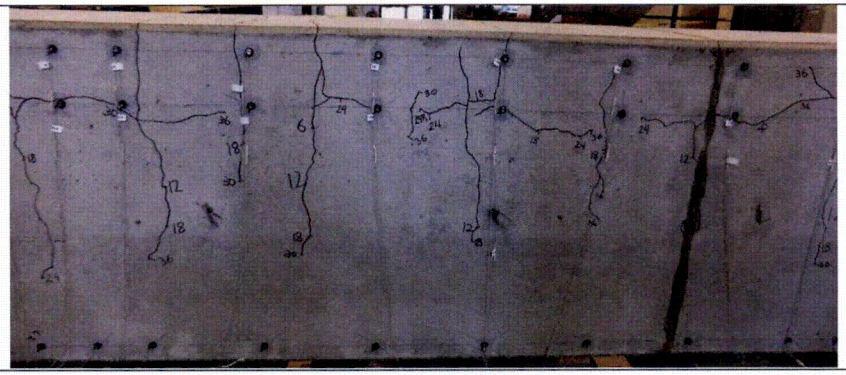
GIRDER B3 – Load = 36 kip

No reload

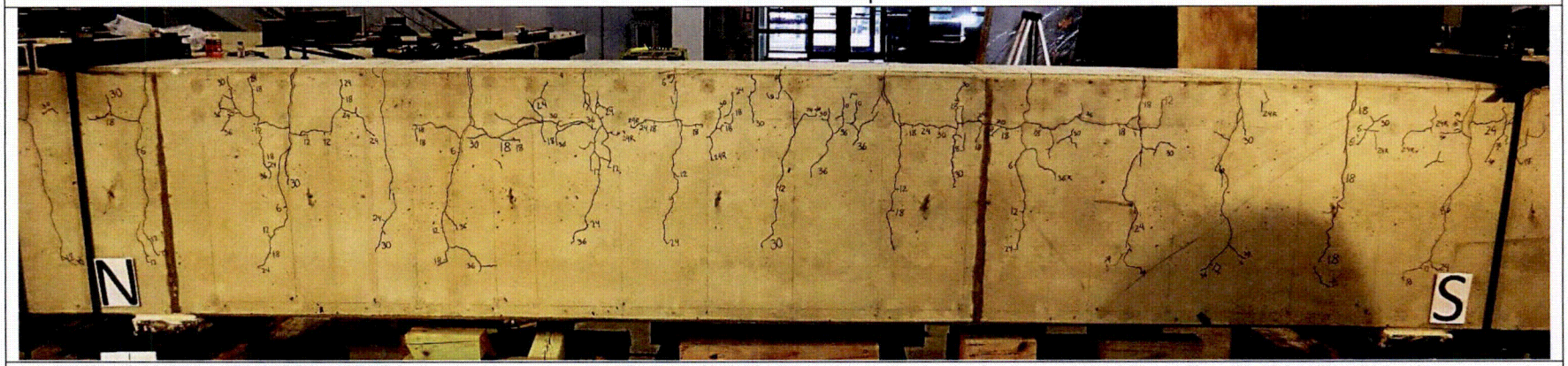
GIRDER B4

REDACTED VERSION

RELOADING



GIRDER B5 – 24 kip.



GIRDER B6 – 36 kip.

Project: Tests to Determine the Behavior of Spliced #11 Bars

Instrumentation Documentation v.1
(Rev. 04/01/2012)

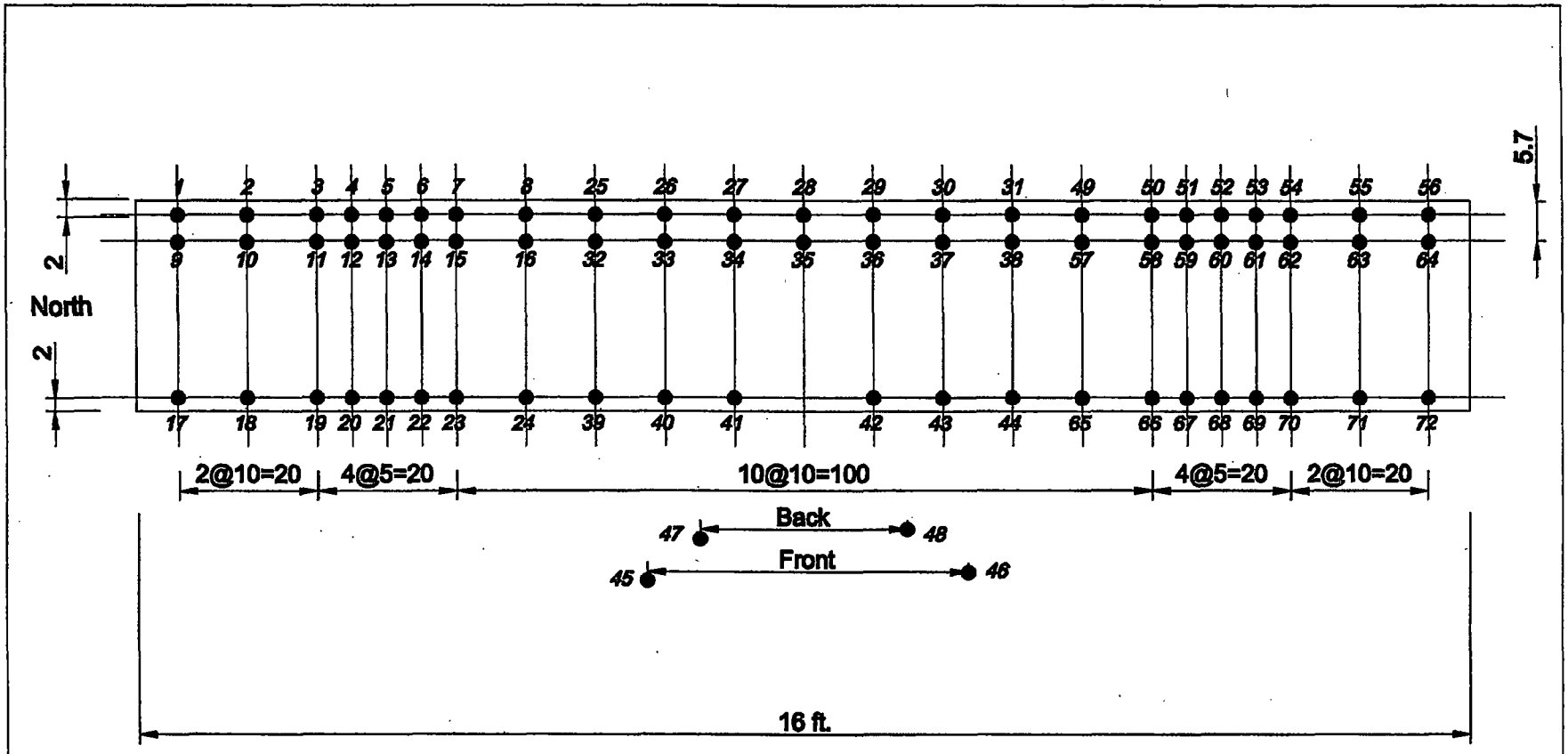
Specimen: A-1

Sheet 1 of 1

Data Acquisition System:								
Channel #	Gain	Excitation V.	Sensor	S.N.	[in/V] Sensitivity	[in] Zero Offset	Location	Zeroes [V] Comments
0 M1-0	1	3.333	PA-20	37100980	-6.197	-17.26	N. Overhang	2.785
1 M1-1	1	"	"	37100981	-6.167	-17.02	S. "	2.759
2 M1-2	1	"	PA-10	40010986	3.175	1.18	N. Splice End	0.372
3 M1-3	1	"	"	40010991	3.169	0.87	Midspan	0.274
4 M2-0	1	"	"	40010988	3.173	1.08	S. Splice End	0.339
5 M2-2	100	10	Lebow 50K	443	-2556	0.2 [K]	N. End	-0.000044
6 M2-3	100	10	"	442	-2563	0.2 [K]	S. "	-0.000033
7 M3-0	1	30	Lucas 2	J7250	0.208	0.005	N. Support	0.027
8 M3-1	1	30	"	J7251	0.209	0.000	S. "	0.000

Operator	Signature	Date	Time
BPR		6/2/12	2:40 PM
Checked by	Signature	Date	Time
KAA		6-2-12	2:40 pm
Checked by	Signature	Date	Time

Notes:



BOWEN LABORATORY PURDUE UNIVERSITY	Specimen A-1				
	Behavior of Lap Splices of No. 11 Reinforcing Bars	Drawn by:	BPR	Checked by:	KAM
		Date:	6/2/12		

Project: Tests to Determine the Behavior of Spliced #11 Bars

Instrumentation Documentation v.1
(Rev. 04/01/2012)

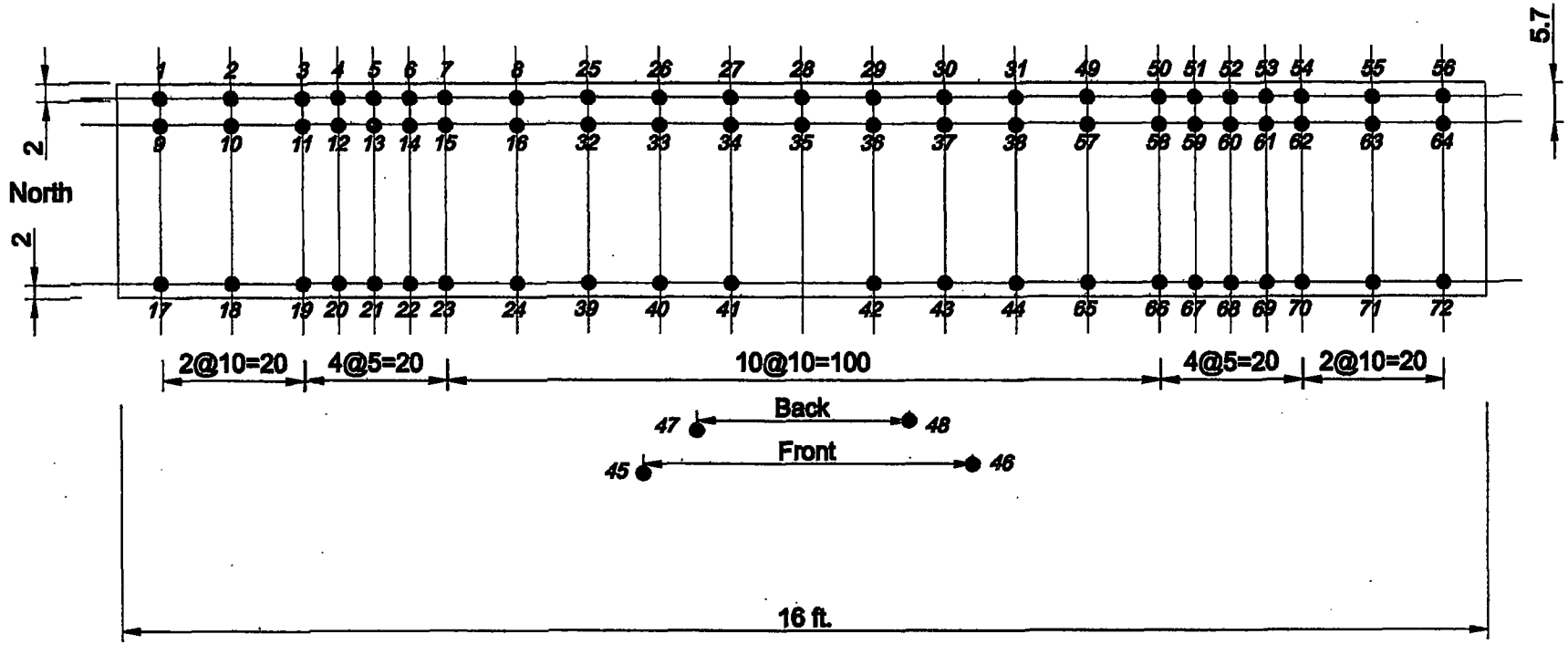
Specimen: A-2

Sheet 1 of 1

Data Acquisition System:								
Channel #	Gain	Excitation V.	Sensor	S.N.	(in/v) Sensitivity	(in) Zero Offset	Location	Zeroes (v) Comments
0 M1-0	1	3.333	PA-20	37100980	-6.197	-17.04	N. Overhang	2.750
1 M1-1	1	"	"	37100981	-6.167	-17.31	S. "	2.807
2 M1-2	1	"	PA-10	40010986	3.175	1.26	N. Splice End	0.396
3 M1-3	1	"	"	40010991	3.169	0.82	Midspan	0.260
4 M2-0	1	"	"	40010988	3.173	0.99	S. Splice End	0.311
5 M2-2	100	10	Lebow 50K	443	-2556	0.3 [K]	N. End	-0.000060
6 M2-3	100	10	"	442	-2563	0.2 [K]	S. "	-0.000036
7 M3-0	1	30	Lucas 2	J7250	0.208	0.004	N. Support	0.013
8 M3-1	1	30	"	J7251	0.209	-0.004	S. "	-0.025

Operator	Signature	Date	Time
BPR	[signature]	5/31/12	5:10 PM
Checked by	Signature	Date	Time
KAM	[signature]	5-31-12	5:30 pm
Checked by	Signature	Date	Time

Notes:



BOWEN LABORATORY PURDUE UNIVERSITY	Specimen A-2			
	Behavior of Lap Splices of No. 11 Reinforcing Bars	Drawn by: BPR	Checked by: RAM	
		Date: 5/31/12		

Project: Tests to Determine the Behavior of Spliced #11 Bars

Instrumentation Documentation v.1
(Rev. 04/01/2012)

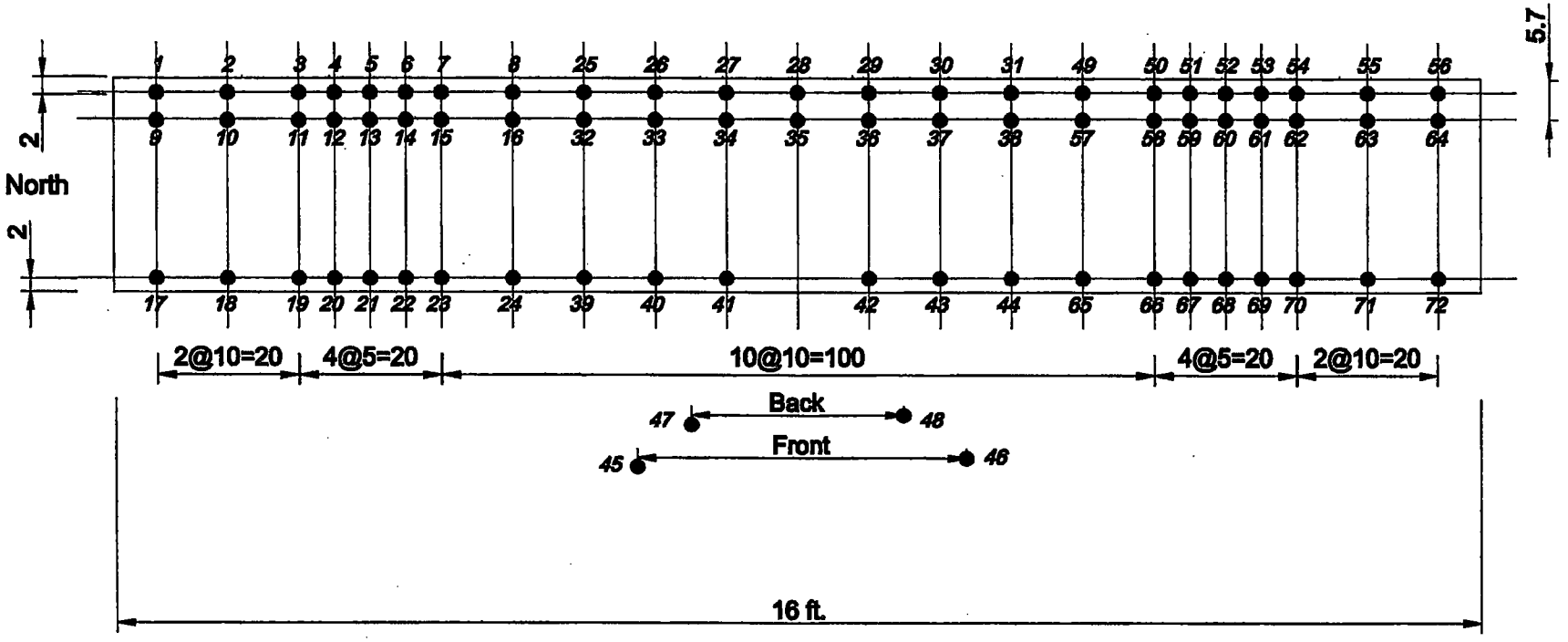
Specimen: A-3

Sheet 1 of 1

Data Acquisition System:						BPR 5/29/12		
Channel #	Gain	Excitation V.	Sensor	S.N.	[in/V] Sensitivity	[in] Zero Offset	Location	~~Zeroes~~[V] Comments
0 M1-0	1	3.333	PA-20	37100980	-6.197	~~-18.~~ -17.43	N. Overhang	2.813
1 M1-1	1	"	"	37100981	-6.167	-17.13	S. "	2.777
2 M1-2	1	"	PA-10	40010986	3.175	1.19	N. Splice End	0.376
3 M1-3	1	"	"	40010991	3.169	0.90	Midspan	0.283
4 M2-0	1	"	"	40010988	3.173	1.15	S. Splice End	0.362
5 M2-2	100	10	Lebow 50K	443	-2556	0.2[K]	N. End	-0.000034
6 M2-3	100	10	"	442	-2563	0.2[K]	S. "	-0.000031
7 M3-0	1	30	Lucas 2	J7250	0.208	-0.003	N. Support	-0.016
8 M3-1	1	30	"	J7251	0.209	-0.001	S. "	-0.007

Operator	Signature	Date	Time
BPR		5/29/12	9:20 PM
Checked by	Signature	Date	Time
J.N.H.		5.29.12	9:20
Checked by	Signature	Date	Time

Notes:



BOWEN LABORATORY PURDUE UNIVERSITY	Specimen A-3				
	Behavior of Lap Splices of No. 11 Reinforcing Bars	Drawn by:	BPR	Checked by:	KAM
		Date:	5/29/12		

Project: Tests to Determine the Behavior of Spliced #11 Bars

Instrumentation Documentation v.1
(Rev. 04/01/2012)

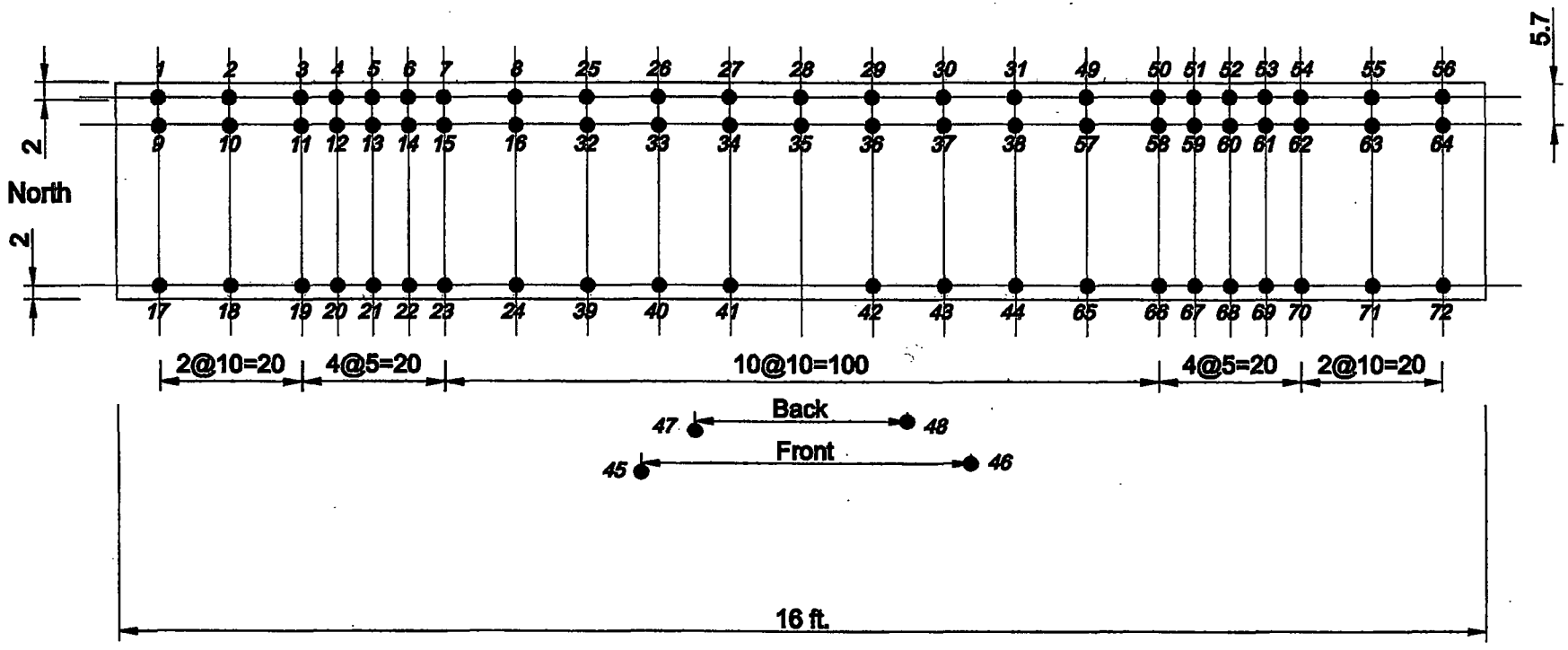
Specimen: A-4

Sheet 1 of 1

Data Acquisition System:								
Channel #	Gain	Excitation V.	Sensor	S.N.	(in/v) Sensitivity	[in] Zero Offset	Location	Zeroes [V] Comments
0 M1-0	1	3.333	PA-20	37100980	-6.197	-17.08	N. Overhang	2.757
1 M1-1	1	"	"	37100981	-6.167	-17.45	S. "	2.830
2 M1-2	1	"	PA-10	40010986	3.175	1.22	N. Splice E.	0.383
3 M1-3	1	"	"	40010991	3.169	0.86	Midspan	0.271
4 M2-0	1	"	"	40010988	3.173	1.05	S. Splice E.	0.332
5 M2-2	100	10	Lebow 50K	443	-2556	~~0.007~~ BPR 6/7 0.3 [K]	N. End	-0.000056
6 M2-3	100	10	"	442	-2563	0.3 [K]	S. End	-0.000055
7 M3-0	1	30	Lucas 2	J7250	0.208	0.007	N. Support	0.035
8 M3-1	1	30	"	J7251	0.209	-0.007	S. "	-0.034

Operator	Signature	Date	Time
BPR		6/7/12	10:30 PM
Checked by	Signature	Date	Time
KAM		6-7-12	10:30 pm
Checked by	Signature	Date	Time

Notes:



BOWEN LABORATORY PURDUE UNIVERSITY	Specimen A-4				
	Behavior of Lap Splices of No. 11 Reinforcing Bars	Drawn by:	BPR	Checked by:	KAM
		Date:	6/7/12		

REDACTED VERSION

Project: Tests to Determine the Behavior of Spliced #11 Bars

Instrumentation Documentation v.1
(Rev. 04/01/2012)

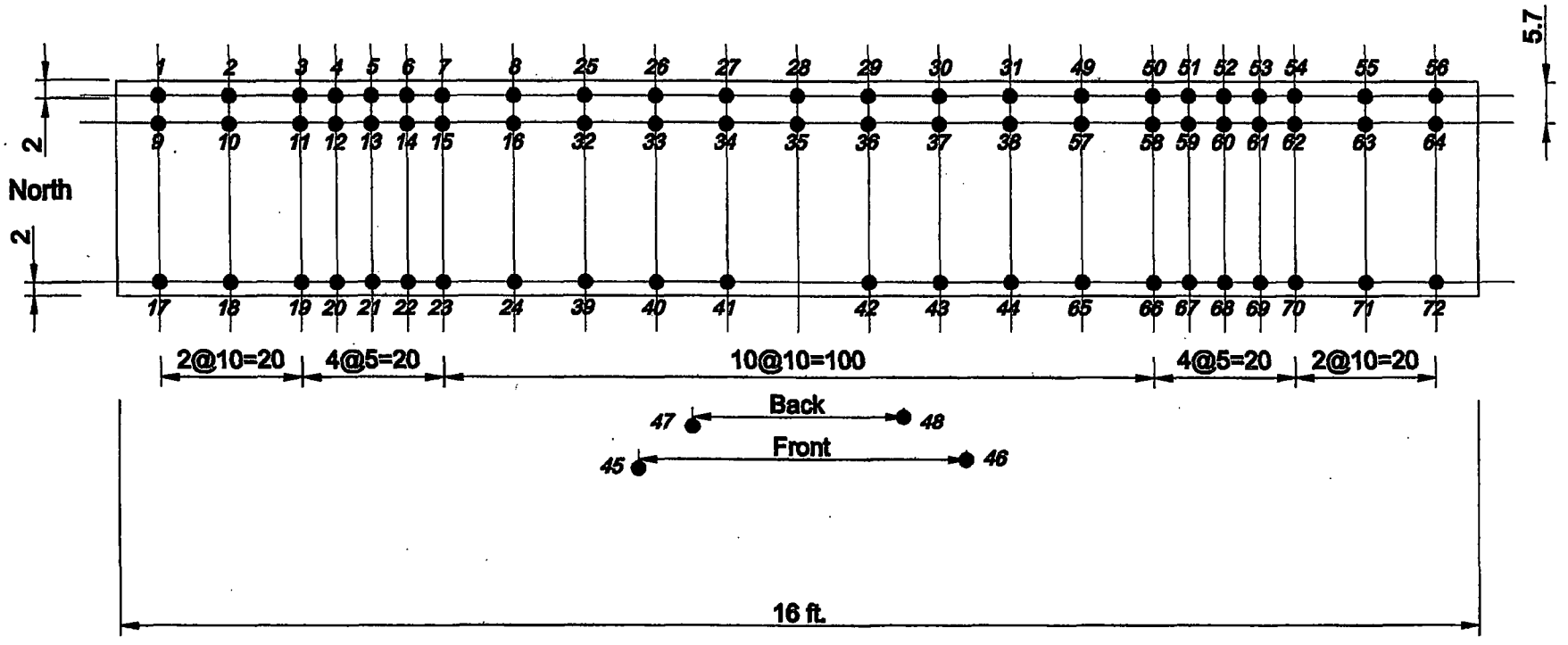
Specimen: A-5

Sheet 1 of 1

Data Acquisition System:								
Channel #	Gain	Excitation V.	Sensor	S.N.	(in/v) Sensitivity	[in] Zero Offset	Location	Zeroes (V) Comments
0 M1-0	1	3.333	PA-20	37100980	-6.197	-17.40	N. Overhang	2.808
1 M1-1	1	"	"	37100981	-6.167	-16.96	S. "	2.750
2 M1-2	1	"	PA-10	40010986	3.175	1.10	N. Splice End	0.349
3 M1-3	1	"	"	40010991	3.169	0.72	Midspan	0.230
4 M2-0	1	"	"	40010988	3.173	0.98	S. Splice End	0.310
5 M2-2	100	10	Lebow 50K	443	-2556	0.2 [K]	N. End	-0.000038
6 M2-3	100	10	"	442	-2563	0.2 [K]	S. "	-0.000037
7 M3-0	1	30	Lucas 2	J7250	0.208	0.006	N. Support	0.027 BPR 6/6
8 M3-1	1	30	"	J7251	0.209	-0.005	S. "	-0.026 BPR 6/6

Operator	Signature	Date	Time
BPR		6/6/12	5:30 PM
Checked by	Signature	Date	Time
J.N.H.		6.6.12	5:45 P
Checked by	Signature	Date	Time

Notes:



BOWEN LABORATORY PURDUE UNIVERSITY	Specimen A-5				
	Behavior of Lap Splices of No. 11 Reinforcing Bars	Drawn by:	BPR	Checked by:	KAM
		Date:	6/6/12		

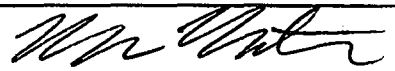
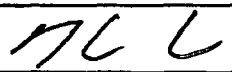
Project: Tests to Determine the Behavior of Spliced #11 Bars

Instrumentation Documentation v.1
(Rev. 04/01/2012)

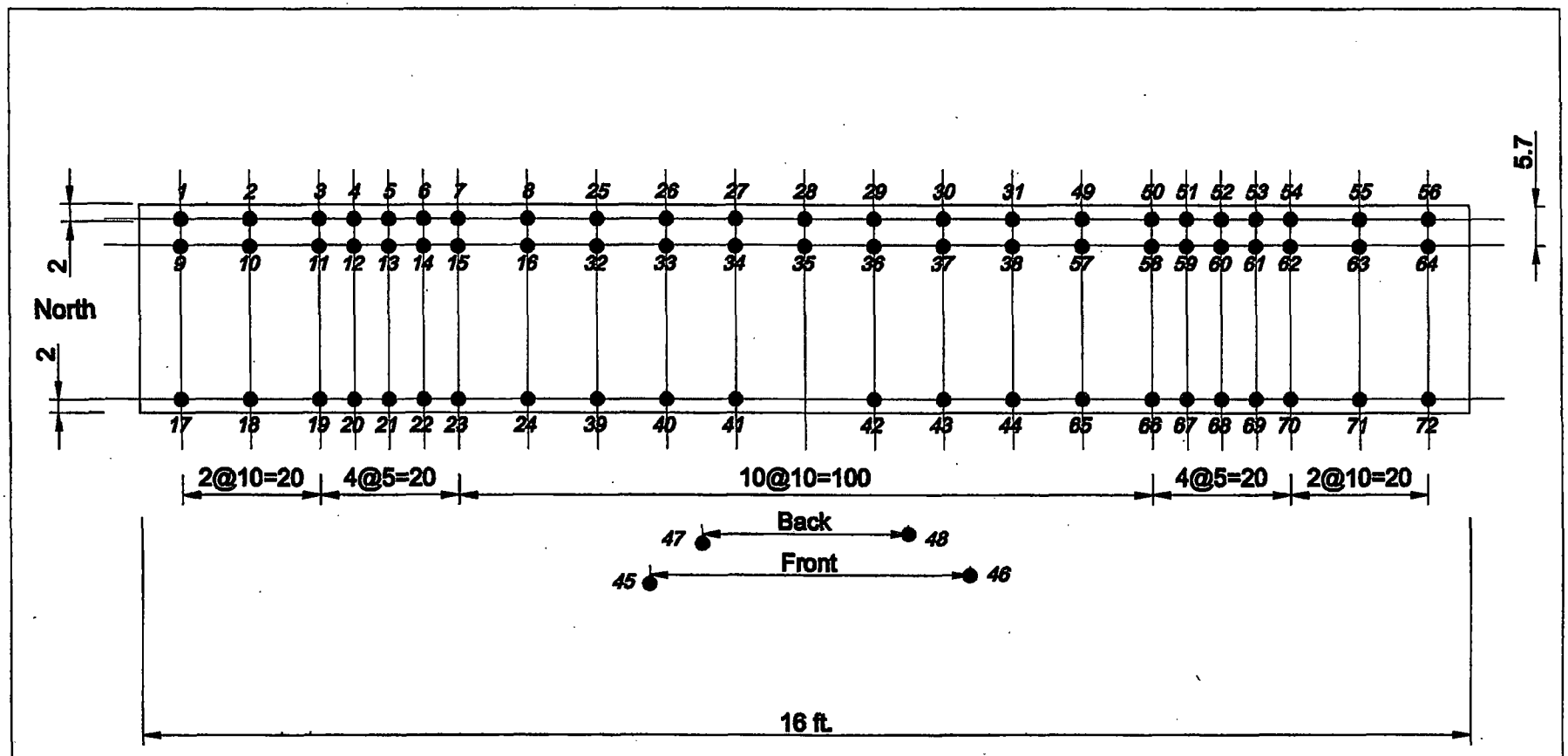
Specimen: A-6

Sheet 1 of 1

Data Acquisition System:								
Channel #	Gain	Excitation V.	Sensor	S.N.	(in/v) Sensitivity	[in] Zero Offset	Location	Zeroes (v) Comments
0 M1-0	1	3.333	PA-20	37100980	-6.197	BPR 6/5 ~~2.78~~ -17.23	N. Overhang	2.780
1 M1-1	1	"	"	37100981	-6.167	-17.01	S. "	2.758
2 M1-2	1	"	PA-10	40010986	3.175	1.10	N. Splice End	0.347
3 M1-3	1	"	"	40010991	3.169	0.84	Midspan	0.264
4 M2-0	1	"	"	40010988	3.173	1.00	S. Splice End	0.316
5 M2-2	100	10	Lebow 50K	443	-2556	BPR 6/5 ~~0.006~~ 0.3 [K]	N. End	-0.000057
6 M2-3	100	10	"	442	-2563	BPR 6/5 ~~-0.007~~ 0.2 [K]	S. End	-0.000036
7 M3-0	1	30	Lucas 2	J7250	0.208	0.006	N. Support	0.029
8 M3-1	1	30	"	J7251	0.209	-0.007	S. "	-0.034

Operator	Signature	Date	Time
BPR		6/4/12	11:00 AM
Checked by	Signature	Date	Time
KAM		6-4-12	11:00 am
Checked by	Signature	Date	Time

Notes:



BOWEN LABORATORY PURDUE UNIVERSITY	Specimen A-6				
	Behavior of Lap Splices of No. 11 Reinforcing Bars	Drawn by:	BPR	Checked by:	KAM
		Date:	6/4/12		

Project: Tests to Determine the Behavior of Spliced #11 Bars

Instrumentation Documentation v.1 (Rev. 04/01/2012)

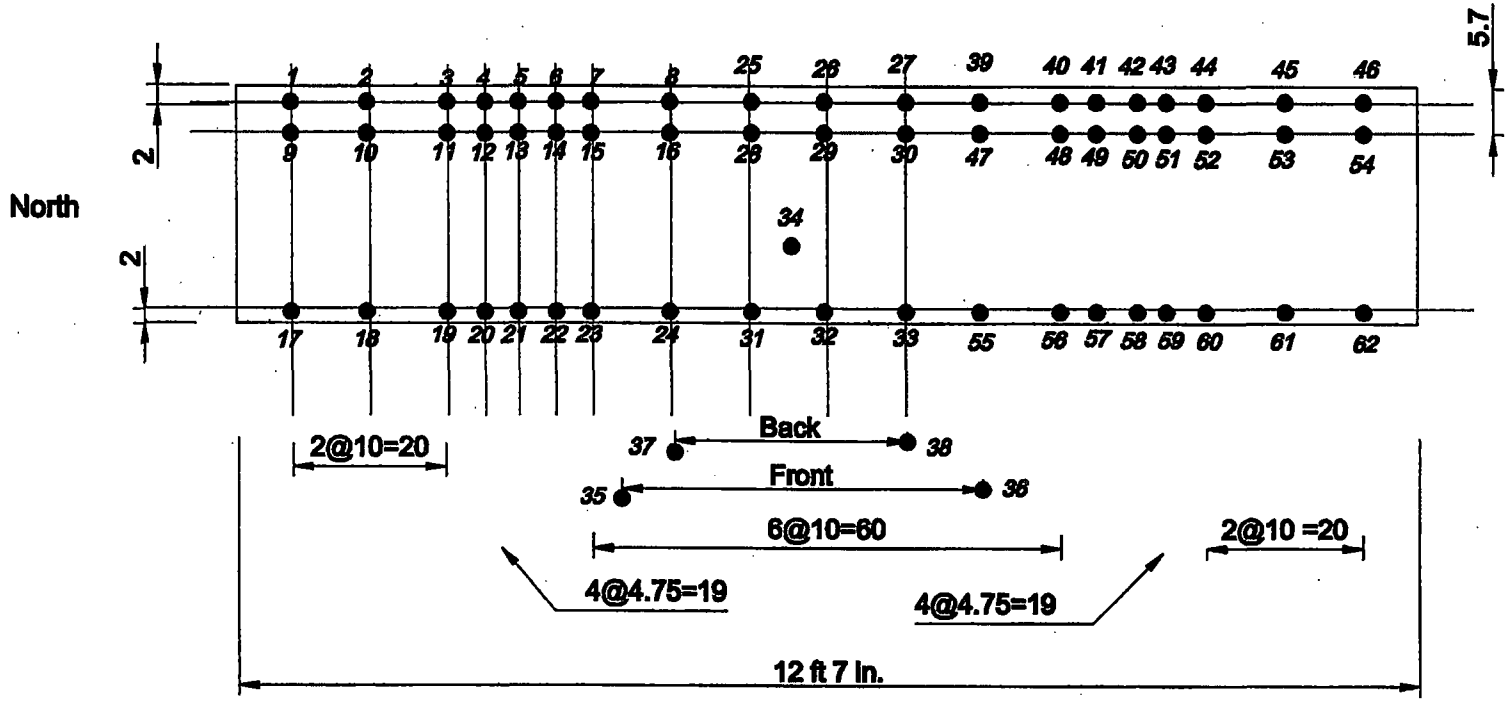
Specimen: B-1

Sheet 1 of 1

Data Acquisition System:								
Channel #	Gain	Excitation V.	Sensor	S.N.	(in./V) Sensitivity	(in.) Zero Offset	Location	Zeros (V.) Comments
0 M1-0	1	3.333	PA-20	371 00980	-6.197	-18.68	N. Overhang	3.013
1 " 1	1	"	"	371 00981	-6.167	-17.01	S. "	2.745
2 " 2	1	"	PA-10	400 10980	3.175	0.74	N. Splice end	0.235
3 " 3	1	"	"	400 10985	3.169	0.54	Midspan	0.170
4 M2-0	1	"	"	400 10977	3.173	0.91	S. Splice end	0.287
5 M2-2	100	10	Lebow 50k	443	-2556	0.2	N. End	-0.000042
6 " -3	100	10	"	442	-2563	0.2	S. End	-0.000029
7 M3-0	1	30V	Lucas 2"	J7250	0.208	-0.008	N. Support	-0.041
8 M3-1	1	30V	" 2"	J7251	0.209	-0.006	S. "	-0.027

Operator	Signature	Date	Time
S. P.		5/10/12	11 AM
Checked by	Signature	Date	Time
A.J.C.		5/16/12	11 am
Checked by	Signature	Date	Time

Notes:



BOWEN LABORATORY PURDUE UNIVERSITY	Specimen B-1				
	Behavior of Lap Splices of No. 11 Reinforcing Bars	Drawn by:	BPR	Checked by:	KM
		Date:	5/10/12		

Project: Tests to Determine the Behavior of Spliced #11 Bars

Instrumentation Documentation v.1
(Rev. 04/01/2012)

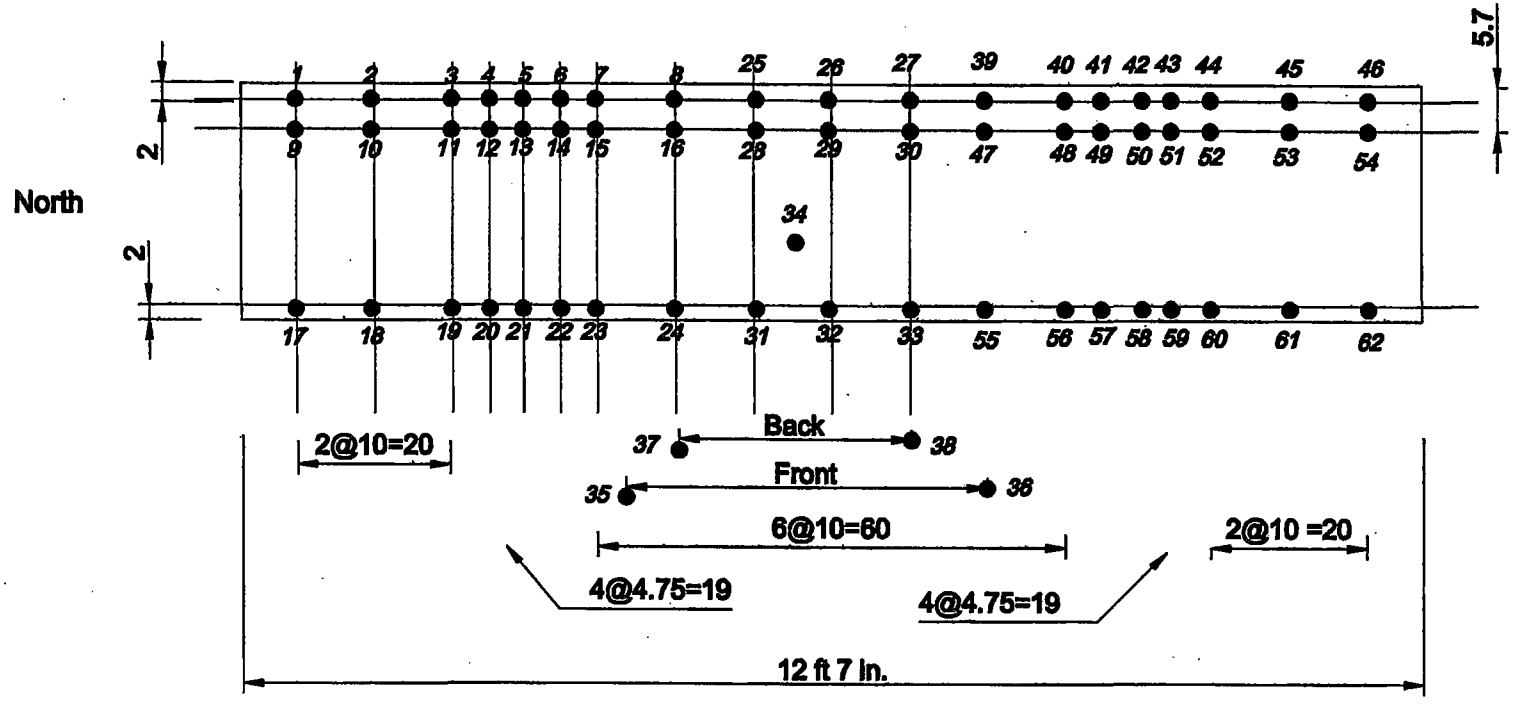
Specimen: B-2

Sheet 1 of 1

Data Acquisition System:								
Channel #	Gain	Excitation V.	Sensor	S.N.	Sensitivity	[in] Zero Offset	Location	Zeroes (V) Comments
0 M1-0	1	3.333	PA-20	37100980	-6.197	-18.60	N. Overhang	3.002
1 M1-1	1	"	"	37100981	-6.167	-17.13	S. Overhang	2.778
2 M1-2	1	"	PA-10	40010986	3.175	+0.74	N. Splice End	0.234
3 M1-3	1	"	"	40010991	3.169	+0.56	Midspan	0.177
4 M2-0	1	"	"	40010988	3.173	+1.12	S. Splice End	0.352
5 M2-2	100	10V	Lebow 50K	443	-2556	0.2 [K]	N. End	-0.000041
6 M2-3	100	10V	"	442	-2563	0.2 [K]	S. End	-0.000036
7 M3-0	1	30V	Lucas 2	J7250	0.208	+0.010	N. Support	0.051
8 M3-1	1	30V	"	J7251	0.209	-0.005	S. Support	-0.024

Operator	Signature	Date	Time
BPR		5/22/12	6:15PM
Checked by	Signature	Date	Time
J.N.H.		5.22.12	6:25 PM
Checked by	Signature	Date	Time

Notes:



BOWEN LABORATORY PURDUE UNIVERSITY	Specimen B-2				
	Behavior of Lap Splices of No. 11 Reinforcing Bars	Drawn by:	BPR	Checked by:	KAM
		Date:	5/22/12		

Project: Tests to Determine the Behavior of Spliced #11 Bars

Instrumentation Documentation v.1
(Rev. 04/01/2012)

Specimen: B-3

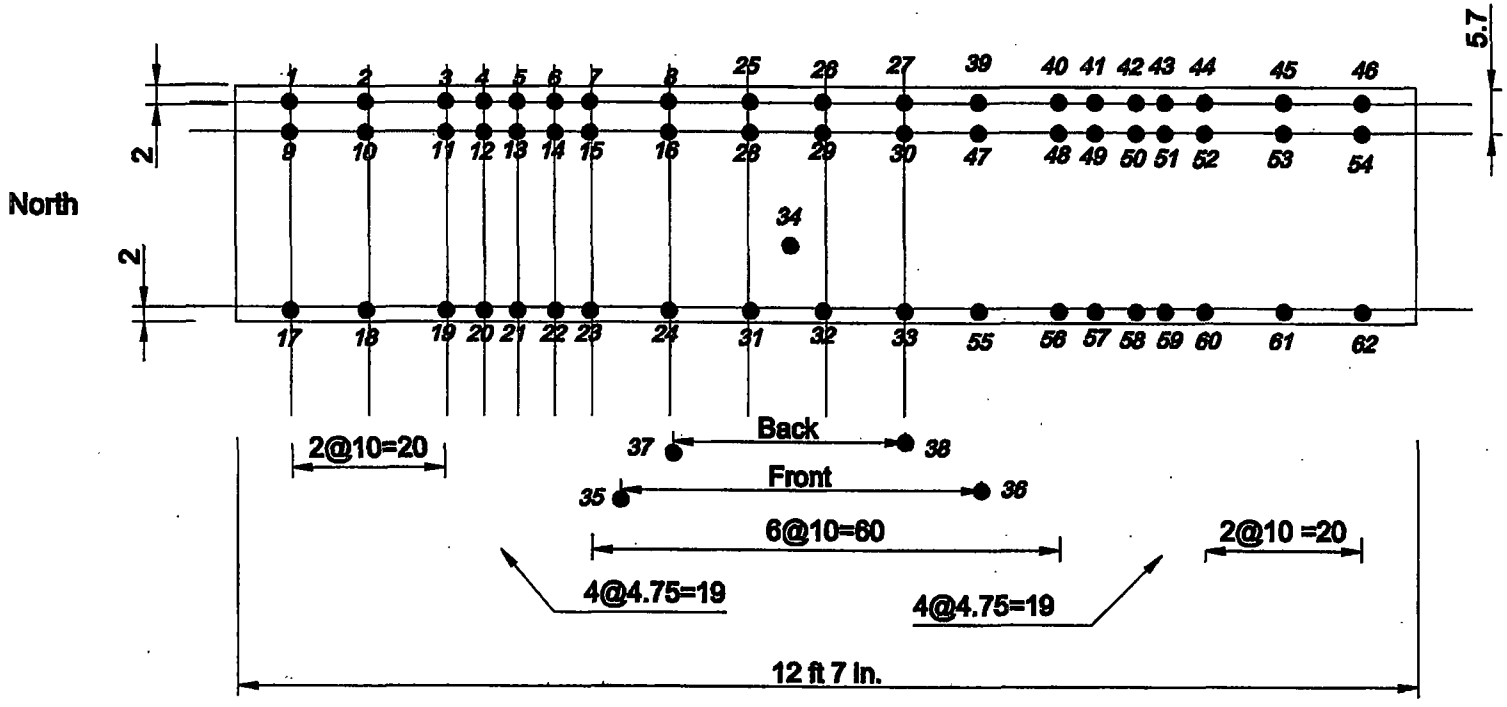
Sheet 1 of 1

Data Acquisition System:								
Channel #	Gain	Excitation V.	Sensor	S.N.	Sensitivity	[in] Zero Offset	Location	Zeroes (V) Comments
0 M1-0	1	3.333	PA-20	37100980	-6.197	-18.99	N. Overhang	3.064 ✓
1 M1-1	1	"	"	37100981	-6.167	-16.99	S. " "	2.755 ✓
2 M1-2	1	"	PA-10	40010986	3.175	0.97	N. Splice End	0.305 ✓
3 M1-3	1	"	"	40010991	3.169	0.64	Midspan	0.203 ✓
4 M2-0	1	"	"	40010988	3.173	1.07	S. Splice End	0.336 ✓
5 M2-2	100	10	Lebow 50K	443	-2556	0.3 [K]	N. End	-0.000060 ✓
6 M2-3	100	10	"	442	-2563	0.2 [K]	S. End	-0.000040 ✓
7 M3-0	1	30	Lucas 2	J7250	0.208	0.014	N. Support	0.067 ✓
8 M3-1	1	30	"	J7251	0.209	-0.006	S. "	-0.028 ✓

Operator	Signature	Date	Time
BPR	[redacted]	5/19/12	5:25 PM
Checked by	Signature	Date	Time
SP	[redacted]	5/19/12	7:15 PM
Checked by	Signature	Date	Time

Notes:

REDACTED VERSION



BOWEN LABORATORY PURDUE UNIVERSITY	Specimen B-3				
	Behavior of Lap Splices of No. 11 Reinforcing Bars	Drawn by:	BPR	Checked by:	LAM
		Date:	5/19/12		

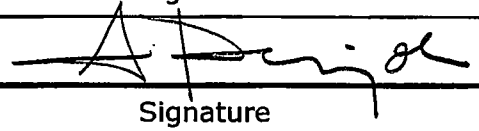
Project: Tests to Determine the Behavior of Spliced #11 Bars

Instrumentation Documentation v.1
(Rev. 04/01/2012)

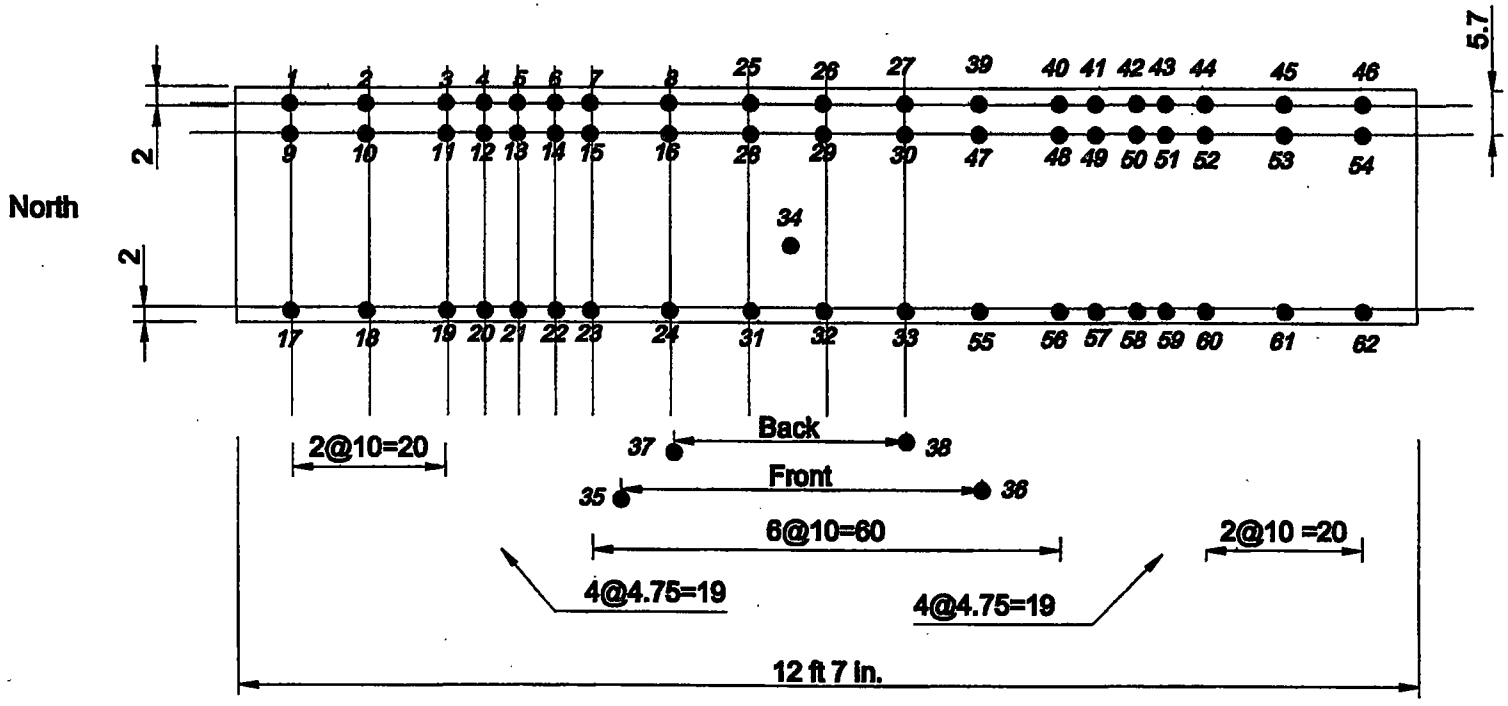
Specimen: B-4

Sheet 1 of 1

Data Acquisition System:								
Channel #	Gain	Excitation V.	Sensor	S.N.	(in/V) Sensitivity	in. Zero Offset	Location	Zero Offset V. Comments
0 M1-0	1	3.333	PA-20	37100980	-6.197	-18.37	N. Overhang	2.965
1 M1-1	1	"	"	37100981	-6.167	-17.04	S. "	2.764
2 M1-2	1	"	PA-10	40010986	3.175	0.62	N. Splice End	0.195
3 M1-3	1	"	"	40010991	3.169	0.46	Midspan	0.146
4 M2-0	1	"	"	40010988	3.173	0.99	S. Splice End	0.312
5 M2-2	100	10V	LC443	443	-2556	0.2	N. End	-0.000042
6 M2-3	100	10V	LC442	442	-2563	0.2	S. End	-0.000040
7 M3-0	1	30V	LVDT	J7250	0.208	-0.005	N. Support	-0.026
8 M3-1	1	30V	LVDT	J7251	0.209	-0.003	S. "	-0.014

Operator	Signature	Date	Time
S.P.		5/12/12	3:46 PM.
Checked by	Signature	Date	Time
BPR		5/12	4:00 PM
Checked by	Signature	Date	Time

Notes: All instruments & settings as in B-1



BOWEN LABORATORY PURDUE UNIVERSITY	Specimen B-4				
	Behavior of Lap Splices of No. 11 Reinforcing Bars	Drawn by:	BPR	Checked by:	KM
		Date:	5/14/12		

Project: Tests to Determine the Behavior of Spliced #11 Bars

Instrumentation Documentation v.1
(Rev. 04/01/2012)

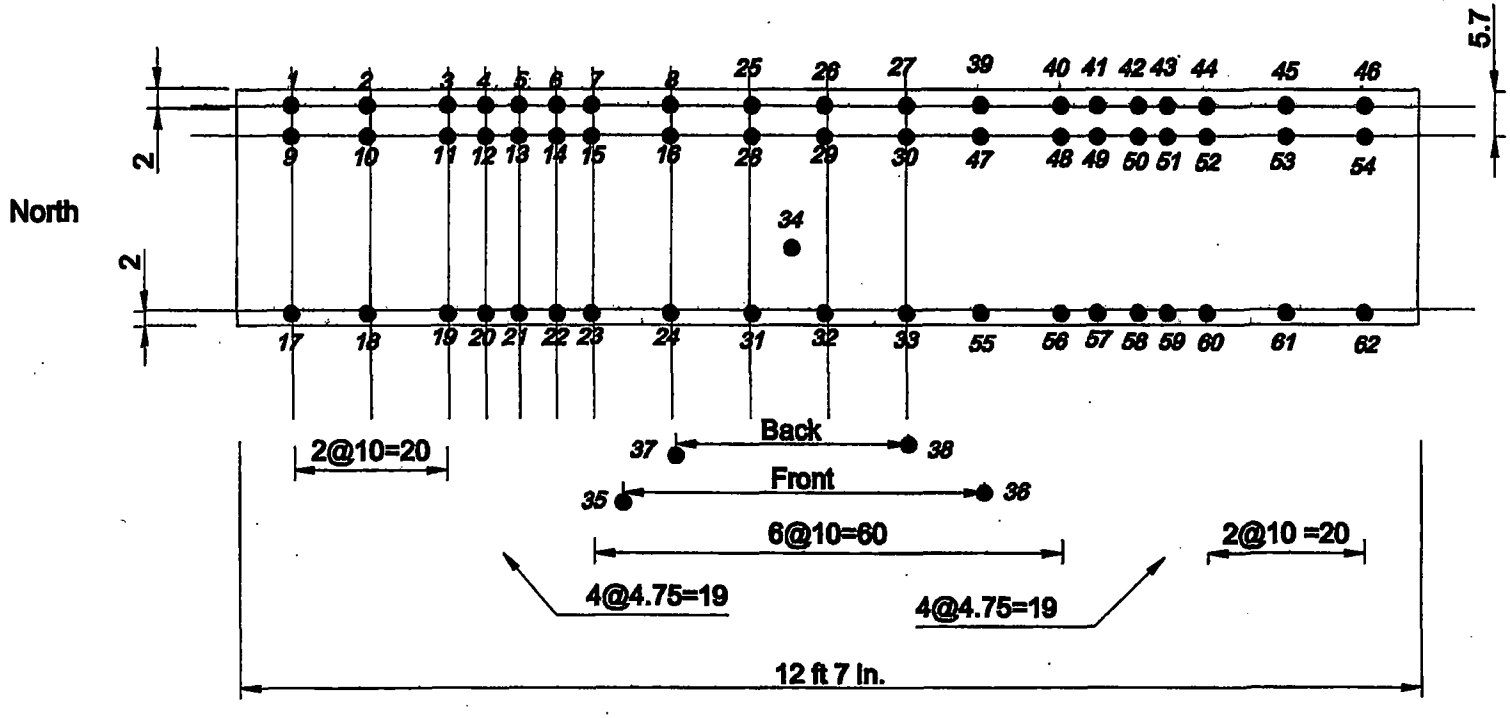
Specimen: B-5

Sheet 1 of 1

Data Acquisition System:								
Channel #	Gain	Excitation V.	Sensor	S.N.	Sensitivity (in/V)	Zero Offset [in]	Location	Zeroes(V) Comments
0 M1-0	1	3.333	PA-20	37100980	-6.197	-18.73	N. Overhang	3.022 ✓
1 M1-1	1	"	"	37100981	-6.167	-16.89	S. "	2.739 ✓
2 M1-2*	1	"	PA-10	40010986*	3.175	+0.72	N. Spliceend	0.225 ✓
3 M1-3	1	"	"	40010991	3.169	+0.48	Midspan	0.153 ✓
4 M2-0	1	"	"	40010988	3.173	+0.97	S. Spliceend	0.305
5 M2-2	100	10V	Lebow 50K	443	-2556	0.2[K]	N. End	-0.000048
6 M2-3	100	10V	"	442	-2563	0.2[K]	S. End	-0.000039
7 M3-0	1	30V	Lucas 2	J7250	0.208	-0.005	N. Support	-0.022
8 M3-1	1	30V	"	J7251	0.209	+0.011	S. "	0.054

Operator	Signature	Date	Time
S. PUJOL			
Checked by	**Signature**	**Date**	**Time**
BPR	[redacted]	5/17/12	12:20PM
Checked by	**Signature**	**Date**	**Time**

Notes: * Cable Replaced.



BOWEN LABORATORY PURDUE UNIVERSITY	Specimen B-5				
	Behavior of Lap Splices of No. 11 Reinforcing Bars	Drawn by:	BPR	Checked by:	VM
		Date:	5/16/12		

Project: Tests to Determine the Behavior of Spliced #11 Bars

Instrumentation Documentation v.1
(Rev. 04/01/2012)

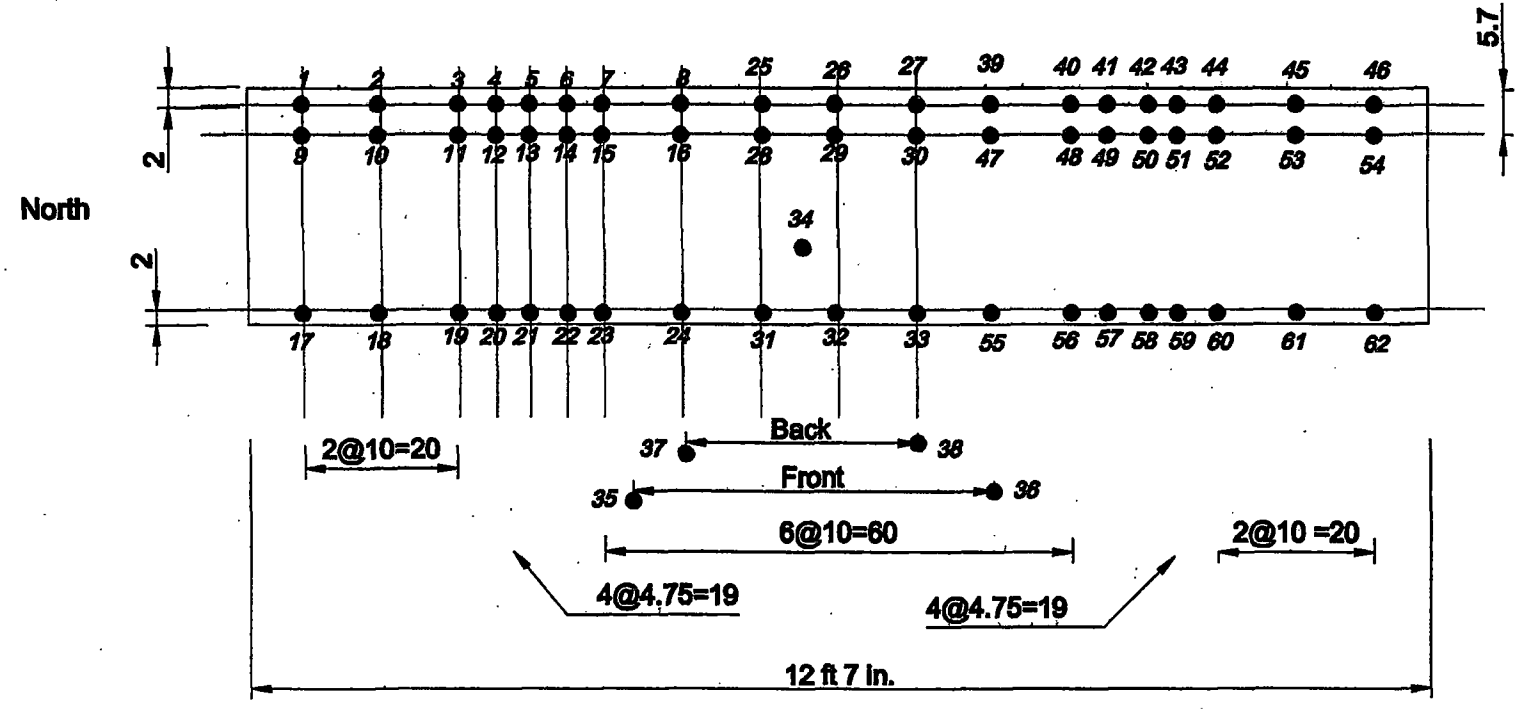
Specimen: B-6

Sheet 1 of 1

Data Acquisition System:								
Channel #	Gain	Excitation V.	Sensor	S.N.	Sensitivity	[in] Zero Offset	Location	Zeroes [V] Comments
0 M1-0	1	3.333	PA-20	37100980	-6.197	-18.86	N. Overhang	3.043
1 M1-1	1	"	"	37100981	-6.167	-17.11	S. Overhang	2.774
2 M1-2	1	"	PA-10	40010986	3.175	0.86	N. Splice End	0.271
3 M1-3	1	"	"	40010991	3.169	0.59	Midspan	0.185
4 M2-0	1	"	"	40010988	3.173	1.15	S. Splice End	0.362
5 M2-2	100	10V	Lebow 50K	443	-2556	0.2 [K]	N. End	-0.000033
6 M2-3	100	10V	"	442	-2563	0.2 [K]	S. End	-0.000036
7 M3-0	1	30V	Lucas 2	J7250	0.208	0.000	N. Support	0.000
8 M3-1	1	30V	"	J7251	0.209	0.002	S. Support	0.013

Operator	Signature	Date	Time
BPR	[redacted]	5/24	5:30PM
Checked by	**Signature**	**Date**	**Time**
KAM	[redacted]	5-24	5:30pm
Checked by	**Signature**	**Date**	**Time**

Notes:



BOWEN LABORATORY PURDUE UNIVERSITY	Specimen B-E6				
	Behavior of Lap Splices of No. 11 Reinforcing Bars	Drawn by:	BPR	Checked by:	KAM
		Date:	5/24/12		