

DEPARTMENT OF TRANSPORTATION
DIVISION OF ENGINEERING SERVICES
Transportation Laboratory
5900 Folsom Boulevard
Sacramento, California 95819-4612



**METHOD FOR EVALUATING BEND TEST RESULTS OF
FUSION-BONDED EPOXY COATINGS ON
ASTM DESIGNATION: A 934/A 934M STEEL REINFORCEMENT**

CAUTION: Prior to handling test materials, performing equipment setups, and/or conducting this method, testers are required to read "**SAFETY AND HEALTH**" in Section F of this method. It is the responsibility of the user of this method to consult and use departmental safety and health practices and determine the applicability of regulatory limitations before any testing is performed.

A. OVERVIEW

The procedures outlined in this document provide a method to visually evaluate the results of bend tests of reinforcement coated with fusion-bonded epoxy coatings applied to prefabricated steel reinforcing bars in accordance with ASTM Designation: A 934/A 934M. The purpose of the bend test for these coatings is to provide a qualitative measure of coating cure and/or failure of coating due to backside contamination through a visual assessment. Other quantitative methods of assessing coating cure and backside contamination are available and required per ASTM Standards; however, successful passing of the bend test is also required.

Information contained in this test method supersedes information contained in sub-Section 9.3.2 of "Coating Flexibility" in ASTM Designation: A 934/A 934M.

B. TERMINOLOGY

1. Fusion-bonded epoxy coating – a product containing pigments, thermosetting epoxy resins, cross-linking agents, and other additives,

which is applied in the form of a powder onto a clean, heated metallic substrate that fuses to the metal to form a continuous barrier coating.

2. Prefabricated bars – steel reinforcing bars that are cut to specified lengths and bent to the required shape prior to coating with fusion-bonded epoxy coatings.
3. Normal or corrected vision – 20/20 vision or better, as verified by a vision acuity test.
4. Standard laboratory lighting – Level of lighting considered typical for inspection work; within the range of 750 to 2000 Lux (1 Lux = 1 Lumen/m²).
5. 10X Magnifying lens – Lens capable of producing a magnification of 10 times that seen with normal or corrected vision.
6. Break – a separation in a coating that extends from the exterior surface of the coating to or near the bar surface. Since the break may be extremely narrow, the underlying metal may not always be visible with 20/20 vision or 10X magnification.

7. Crack – a break in the epoxy coating experienced after bending through which the underlying metal is visible.
8. Coating discontinuity – a break in the coating experienced after bending through which the underlying metal cannot be seen by the unaided eye or with a 10X-magnification device.
9. Isolated coating crack or discontinuity – an isolated break in the coating experienced after the bend test attributed to a burr on the surface of the steel reinforcing bar.
10. Stretching and discoloration – Identifiable changes in color of the fusion-bonded epoxy coating that may occur after bending. Discoloration is an indication of stretching. Note that discoloration of epoxy coating under applied stress does not indicate a separation of the coating.

C. TEST PROCEDURE

1. Figure 1 provides a decision tree for the test procedure.
2. Coated reinforcement test bar samples should be dry and free of contamination prior to testing.
3. Bend coated reinforcement test bar sample in accordance with the requirements of sub-Section 9.3.1 of ASTM A934/A934M.
4. Evaluate the bend area under standard laboratory lighting using normal or corrected vision as identified in this test method.
5. Note the presence of cracks and/or coating discontinuities in the coating on the outside radius of the test bar bend area using normal or corrected vision.
6. Cracks and coating discontinuities as described in this test method are

to be circled with a permanent marker of a contrasting color to that of the epoxy coating. Care should be taken not to mark over the actual crack or discontinuity.

7. If needed, confirm the presence of exposed underlying metal at cracks using a 10X-magnification device.

D. NOTES

1. The intent of this test method is to establish a relatively quick visual test method for assessing the coating cure and integrity of non-bendable fusion-bonded epoxy coatings. The procedure for identifying cracks is intended to be performed by a person with normal or corrected vision. A 10X magnifying lens should only be used to confirm the presence of visible underlying metal at a crack, and should not be used to search for cracks.
2. Holiday detection devices should not be used to identify or confirm the presence of coating cracks or discontinuities.
3. Cracks and coating discontinuities in improperly cured fusion-bonded epoxy-coatings will usually appear at multiple locations along the outside bend radius of the test bar.
4. Three or more cracks on the outside bend radius of the test bar constitute nonconforming material.
5. Three or more coating discontinuities on the outside radius of the test bar constitute nonconforming material.
6. Breaks, cracks or coating discontinuities within the coating at contact points of mandrel devices used to produce the bend in a bar for the bend test should be disregarded.
7. Stretching and/or discoloration of the epoxy coating within the outside

radius of the test bar after bending does not constitute nonconforming material.

8. Figures 2 through 5 may be used to assist in identifying and classifying coating breaks.

E. REPORTING RESULTS

On an appropriate form (Figure 6 is an example) record the number of coating breaks and identify them as either cracks or coating discontinuities on the appropriate test form. Also note whether or not stretching or discoloration was seen on the bar sample after testing.

On an appropriate form (Figure 7 is an example) report results for the test bar as complying or not complying with specifications on the test report form. Results for the test bar sample should be documented with the coating company's name, material lot number, appropriate ASTM coating specification, inspector's name, date sampled and date tested.

F. SAFETY AND HEALTH

Prior to handling, testing or disposing of any waste materials, testers are required to read: Part A (Section 5.0), Part B (Sections: 5.0, 6.0 and 10.0) and Part C (Section 1.0) of Caltrans Laboratory Safety Manual. Users of this method do so at their own risk.

REFERENCE

**California Standard Specifications
ASTM Designation: A 934/A 934M**

**End of Text
(California Test 686 contains 10 pages)**

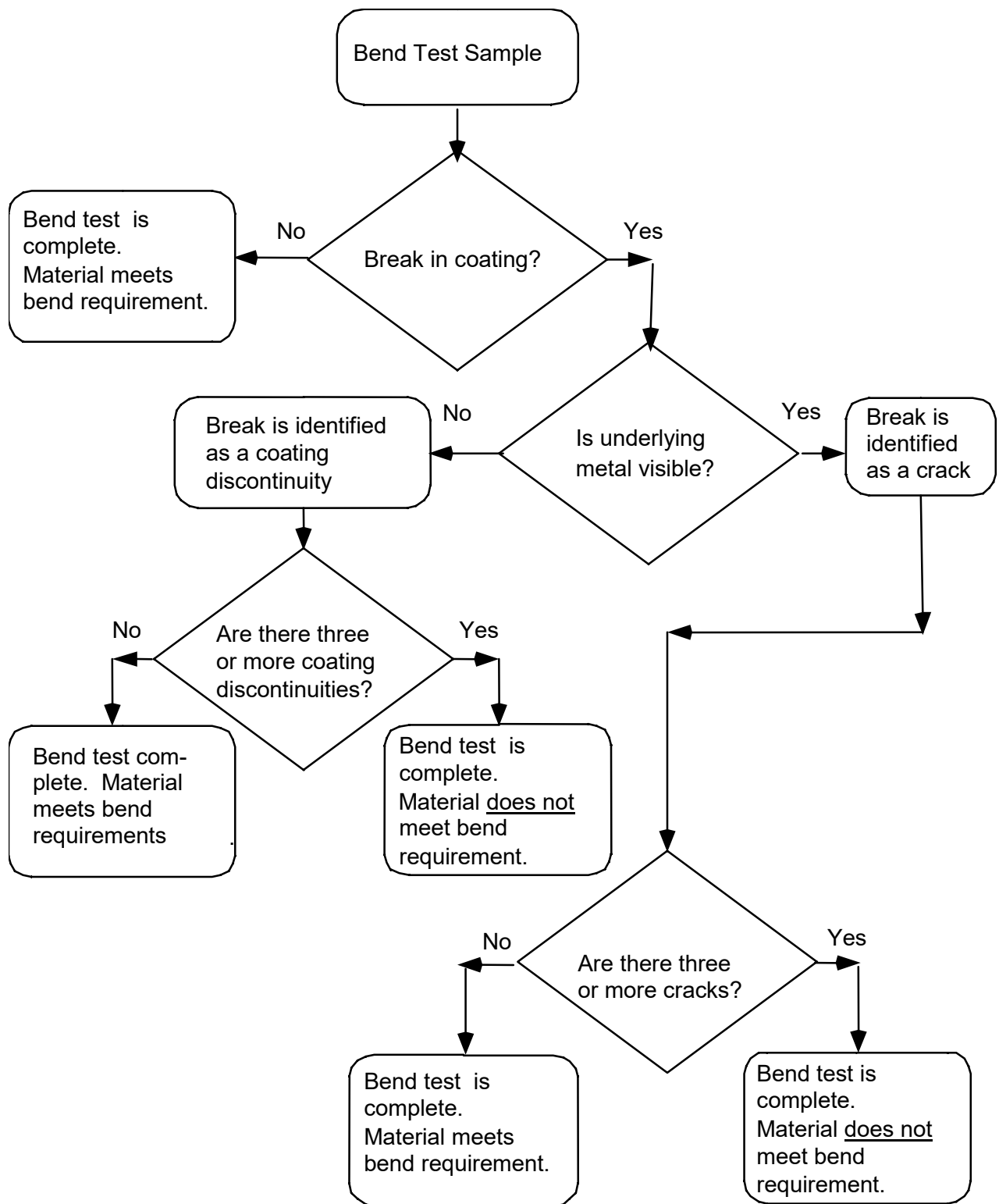


Figure 1. Decision tree for evaluating bend test results.

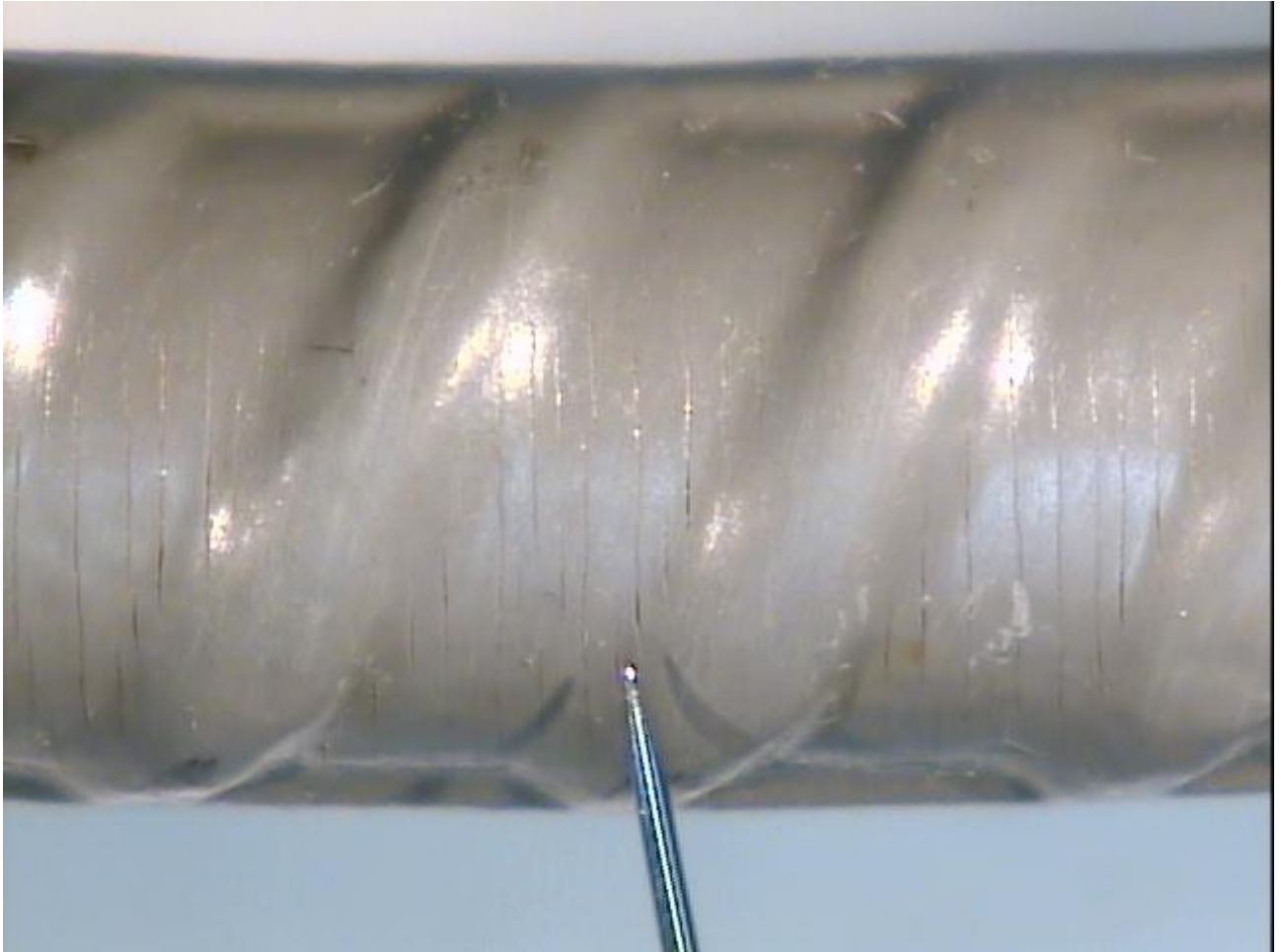


Figure 2 Breaks in the coating after bending that have been identified as coating discontinuities. The discontinuities have a repeated pattern that extends over the entire bend radius. The test bar has failed the bend requirements of this test method.



Figure 3 Test bar showing two of three breaks in the epoxy coating at the outer bend radius of a test bar. The breaks appear to be cracks that expose the underlying metal. Exposed underlying metal can be confirmed, if needed, by viewing with a 10X-magnification device.

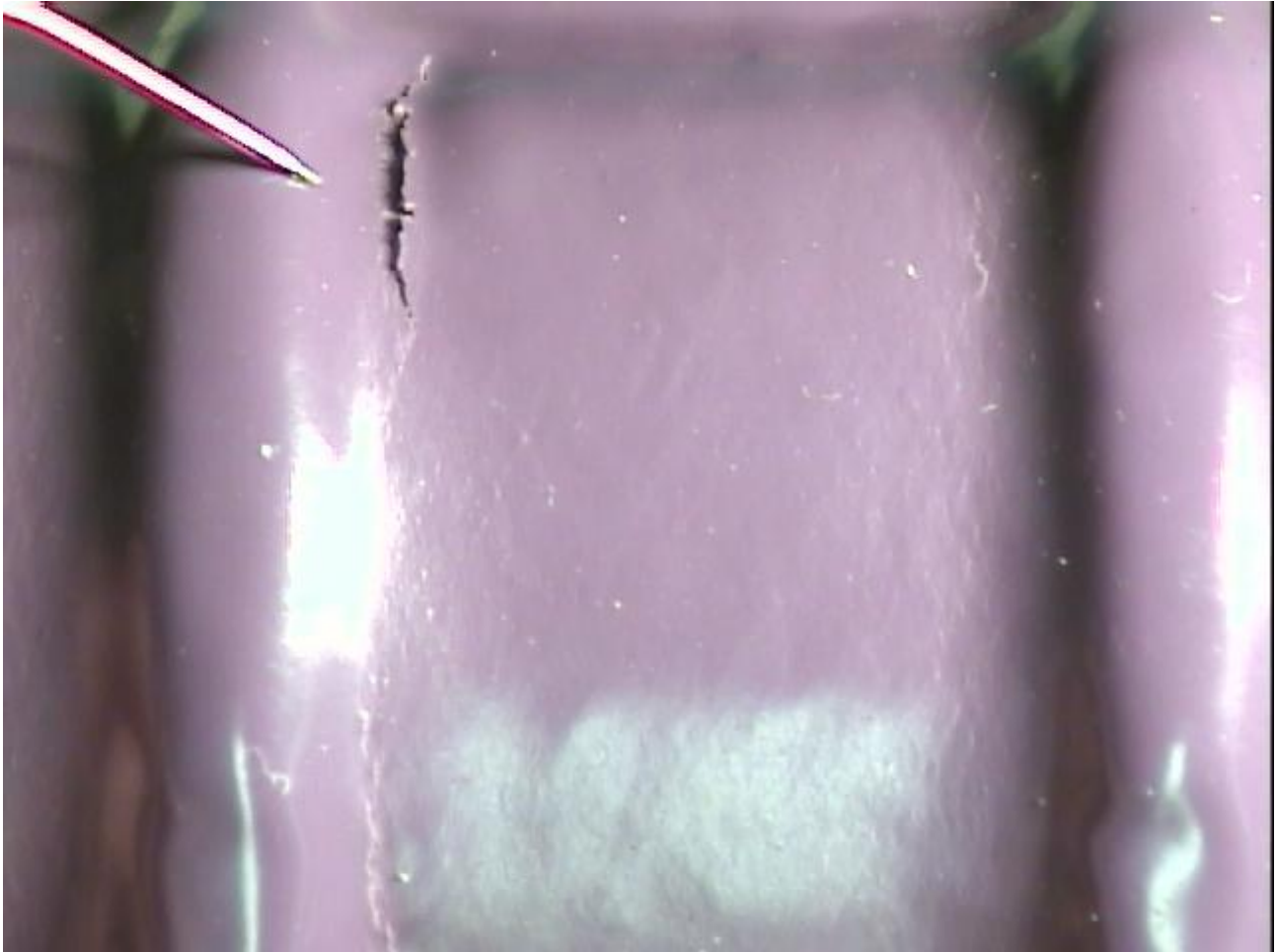


Figure 4 10X magnification of the test sample from the photograph shown in Figure 3. The magnified view shows that the coating is separated from the bar surface and the underlying metal is exposed. The two other breaks on the test bar sample were also identified as cracks. Since the test bar incurred three cracks after bending, it has failed the bend requirements of this test method.

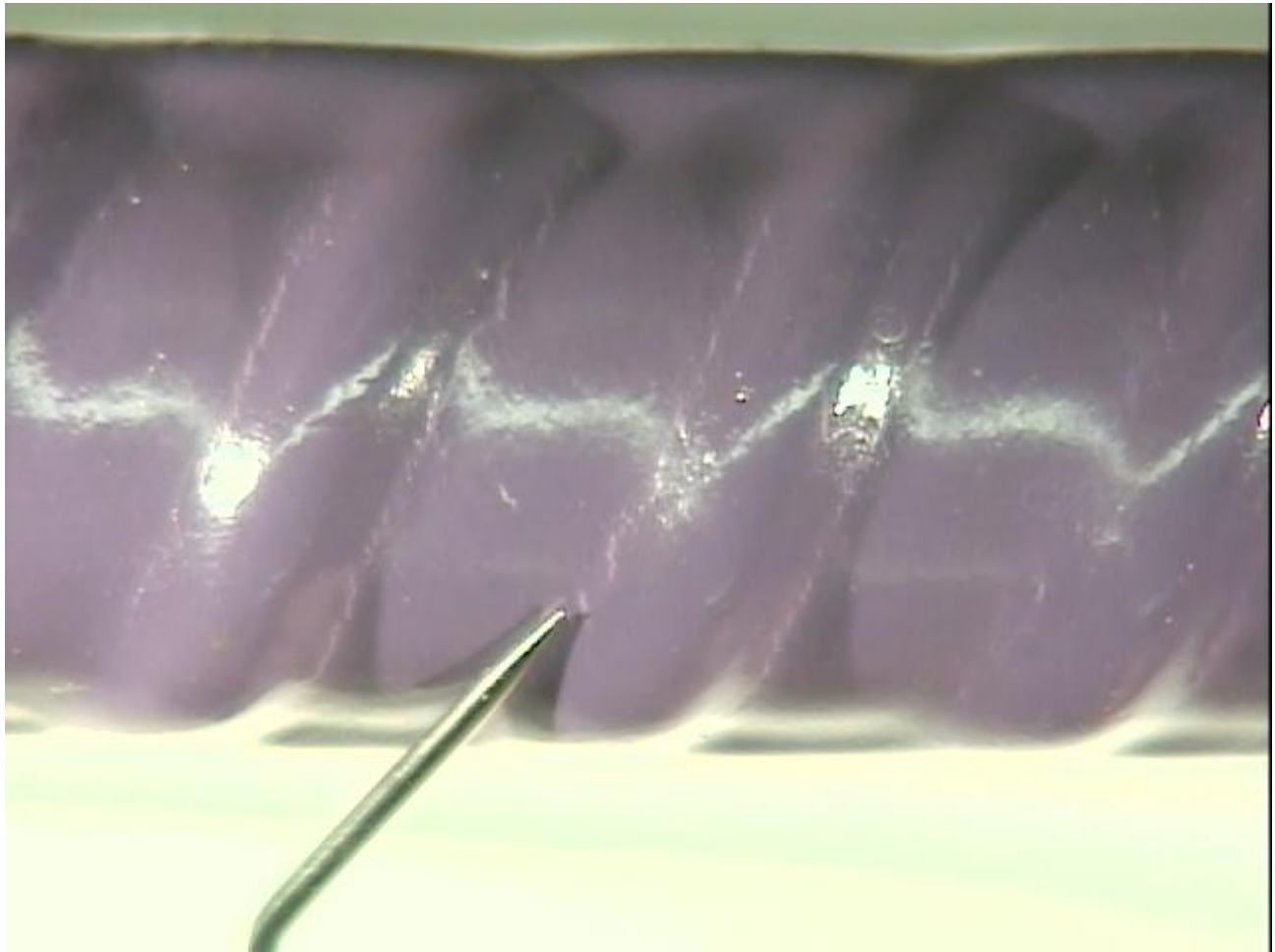


Figure 5 Test sample showing discoloration in coating after the bend test. This type of discoloration is due to stretching of the coating during bending and is typical. Discoloration of the coating after bending does not constitute a failure of the bend test.

Figure 6. Test Form for Recording Bend Test Results

California Test 686 – Bend Test Results	
	SM No.: <u>04-1601</u>
	TL 101 No.: <u>C6301M2</u>
	Date Received: <u>9/18/04</u>
Standard Specs: 52-1.06	Date Tested: <u>9/21/04</u>
ASTM: A934/A934M	Operator: <u>JASON WU</u>
Bend Test:	Lot No.: <u>B6011</u>
Criterion for passing = less than 3 cracks or 3 coating discontinuities.	Contract No.: <u>14-1321M1</u>
	Epoxy Color: <input checked="" type="checkbox"/> Purple <input type="checkbox"/> Gray
	No. of Bars: <u>4</u>
	Bar ID: <u>57</u>
	Length: <u>4'</u>
	Lot/Load/Release No.: <u>H6236</u>
	No. of Coating Breaks: <u>1</u>
	No. of Coating Breaks that are Cracks: <u>0</u>
	No. of Coating Breaks that are Coating Discontinuities: <u>1</u>
	Is any Stretching Observed? <input type="checkbox"/> Yes (evidenced by discoloration) <input checked="" type="checkbox"/> No
	Results: <input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail

Figure 7. Sample Testing Report

SAMPLE TESTING REPORT					
		Remarks ref: Standard Specifications 52-1.06; ASTM A934; Caltrans Test 686 Bend tests pass			
		Date Smpld.	9/18/2004		
		Date Rec'd.	9/21/2004		
		Date Reported	9/23/2004		
Sample No.	SM	04-1601			
Lot No.	B6011		TLSPIN No.	C6301M2	
Contract No.	14-1321M1	Report to	R.E.		
Material	Fusion-bonded epoxy coating on A706 #14				
Manufacturer	XYZ				
Sampler	John Smith	Results Phoned to	(916) 555-5555		
Results	SAMPLES SUBMITTED ARE SATISFACTORY FOR USE				
SOURCE	CHARGE	E.A.	SUB JOB	SPECIAL DESIGNATION	OBJECT
59318	59	14-1321M1	n/a	n/a	1270