INSPECTOR TRAINING FOR MATURITY METHOD FIELD MONITORING

CERTIFICATE (5 Years) (Anyone accepting or opening concrete based on Maturity Method)

- Certification for the individual will be entered into AWP (AASHTO Ware Project)

1. Equipment needed for field monitoring. Equipment used dependent on application and Co. preference.
    - Maturity Meter, Digital Handheld Thermometer, Sensor with Phone App, etc.
    - Type T mini-connecters and Type T thermocouple wire, Wireless Sensors
    - Screwdriver and wire snips for wire preparation
    - electrical tape or duct tape
    - wooden stake or rebar, sledgehammer (Use when tie bars or dowel bars aren't present)
    - Paint, Ribbon, cone, cylinder mold (For the protection of the wires)

2. Prepare wires for installation or sensor
    - Strip the wires and twist the ends together (Pg.8). Program sensor to phone app.
    - Temperature errors occur typically because of three reasons
        - Wire breaks where the two wires are twisted together
        - Wires in the mini-connector are touching
        - Wires in the mini-connector are not connected to the correct pole

3. For PR concrete both wires can be installed in the first patch or place one in the first and one in last. A sensor can be placed in either first or last patch. For Pavement place wire(s) at mid-depth in the side of the slab. For Structures the wires should have min. 2.5" clearance.

4. Wires & sensors can be installed to tie bars, dowel bars a wooden stake or inserted in the concrete slab.
    - If installed to rebar, make sure the end of the wires is not in contact with the rebar.
    - If installing wires or sensor to a wooden stake have adequate clearance from any adjacent concrete.
    - Install the wires or sensor at approximately mid depth of the PR concrete placement.
    - For mainline pavement it is preferred you go into the side of the slab at mid depth.

5. Check the wires after installed and before concrete arrives, take a temperature reading. Your sensor should be programmed to the App before concrete arrives.

6. Within ten minutes after concrete has been placed, take an initial temperature reading if using wires. It is taken in Celsius and read to the nearest whole number. Record this for future calculations

7. Calculate the TTF if using wires and performing manually. The TTF can be read from a maturity meter or phone app if used. Otherwise this can be calculated by entering data into a spreadsheet that will calculate the TTF for you (Pg.7) or you can perform the calculation yourself. For PR concrete, calculating the TTF yourself is the simplest way however you may use the spreadsheet. For mainline paving utilize a spreadsheet that calculates the TTF for you and works as a tool to report your data for your records. If using sensors or a maturity meter the monitoring is done for you.

8. The Inspector will enter project information into the AWP Agency View. On the Tests tab, choose the template "Pavement Repair (Maturity Tests) - Field" for PR concrete. For HE, paving concrete and structures choose the template "Mainline Pavement/Structure Maturity Report - Field"

9. **(Below is an Example and a practice problem on how to calculate the TTF)**

$M(t) = \Sigma (T_a - T_o)\ \Delta t$
$M(t)$ = Time Temperature Factor (Maturity) at age Δt
T_a = Average temperature of the concrete during time interval Δt
T_o = Datum temperature (-10° C) Δt = A time interval (Hours)
(-10° is most common Datum Temp used in the region. 0° could be used. Whichever Is used by your Co. that is what would be used in the equation)

Nurse – Saul Equation

Example 1: The initial temperature of concrete is 20° C when placed, and 3 hours later it was 50° C.

- T_a = (20 + 50) / 2 = **35**
- T_o = always add **10** to the average. When subtracting a negative number add it.
- Δt = elapsed time is **3** hours since the initial temperature was taken

$M(t) = \Sigma (35 + 10) \times 3$
$M(t) = \underline{\mathbf{135}}$

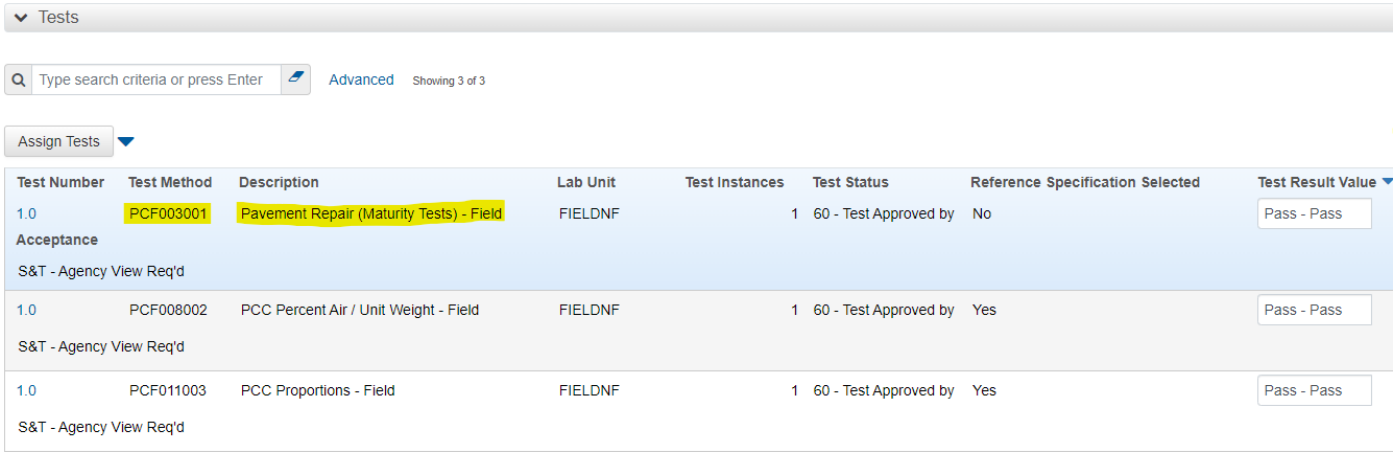
Practice Problem; Initial temperature is 20 C at 12:30 PM. 4 hours later at 4:30 a temperature was taken and it was 50 C.

$M(t) = \Sigma (T_a - T_o)\ \Delta t$
$M(t)$ = Time Temperature Factor (Maturity) at age Δt
T_a = Average temperature of the concrete during time interval Δt
T_o = Datum temperature (-10° C) Δt = A time interval (Hours)

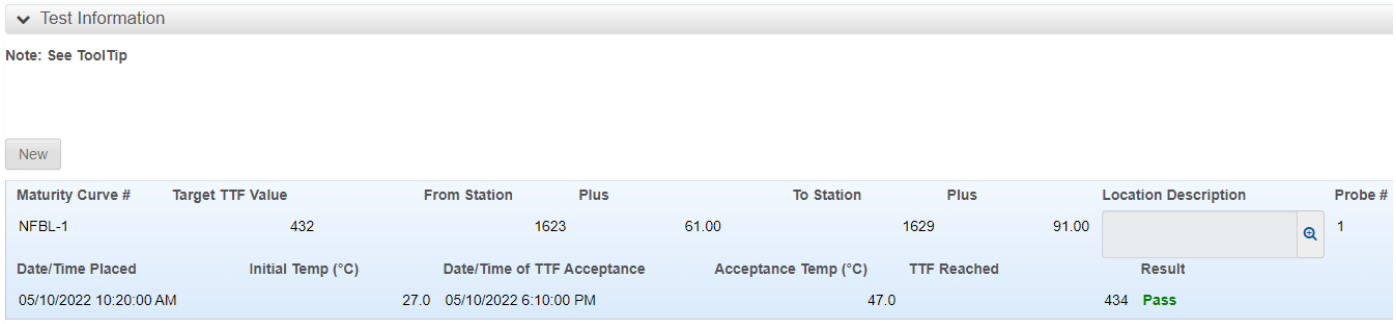
Perform calculation here:

Concrete **Pavement Repair** – Maturity Method (AWP Example)

- Assign the test Agency View (AV) for Pavement Repair (Maturity Tests) – Field
- Choose your Lab for the Lab Unit



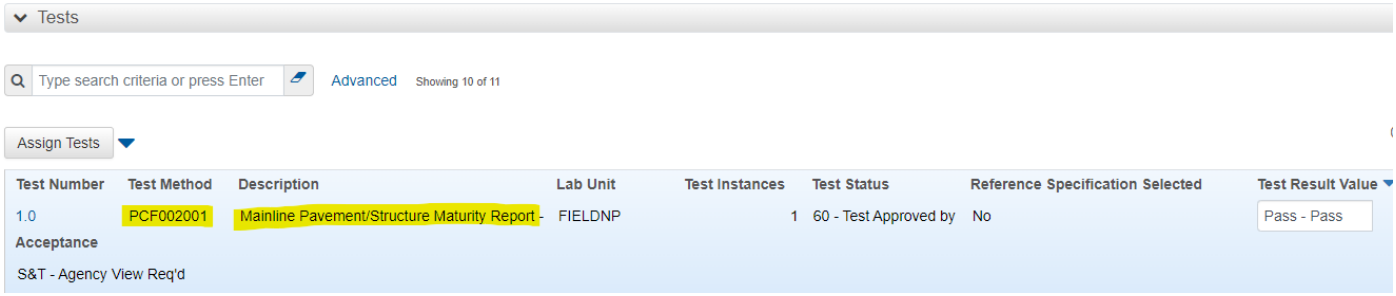
- Click the Blue Carrot to the right of the "Test Result Value" to enter test data, example below of entered data.
- If more than one wire or sensor is monitored click on the New button below to add another AV to enter data in to. Below shows data entered in to only one AV



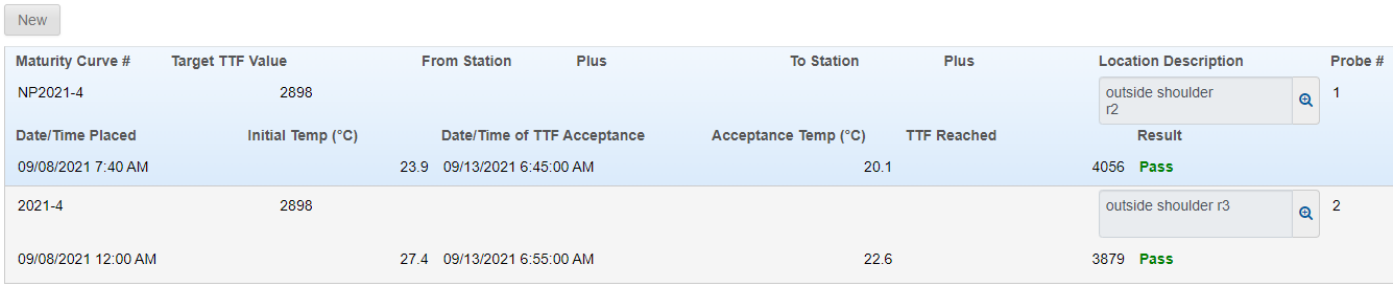
Concrete Pavement, High Early Concrete and Structure – Maturity Method (AWP Example)

- Maturity is used only for opening pavement and form removal of structures. It is not used for ACCEPTANCE of these two items.
- Any pavement that is not covered by cores for acceptance, maturity may be used for opening. However, cylinders will be made and used for acceptance.

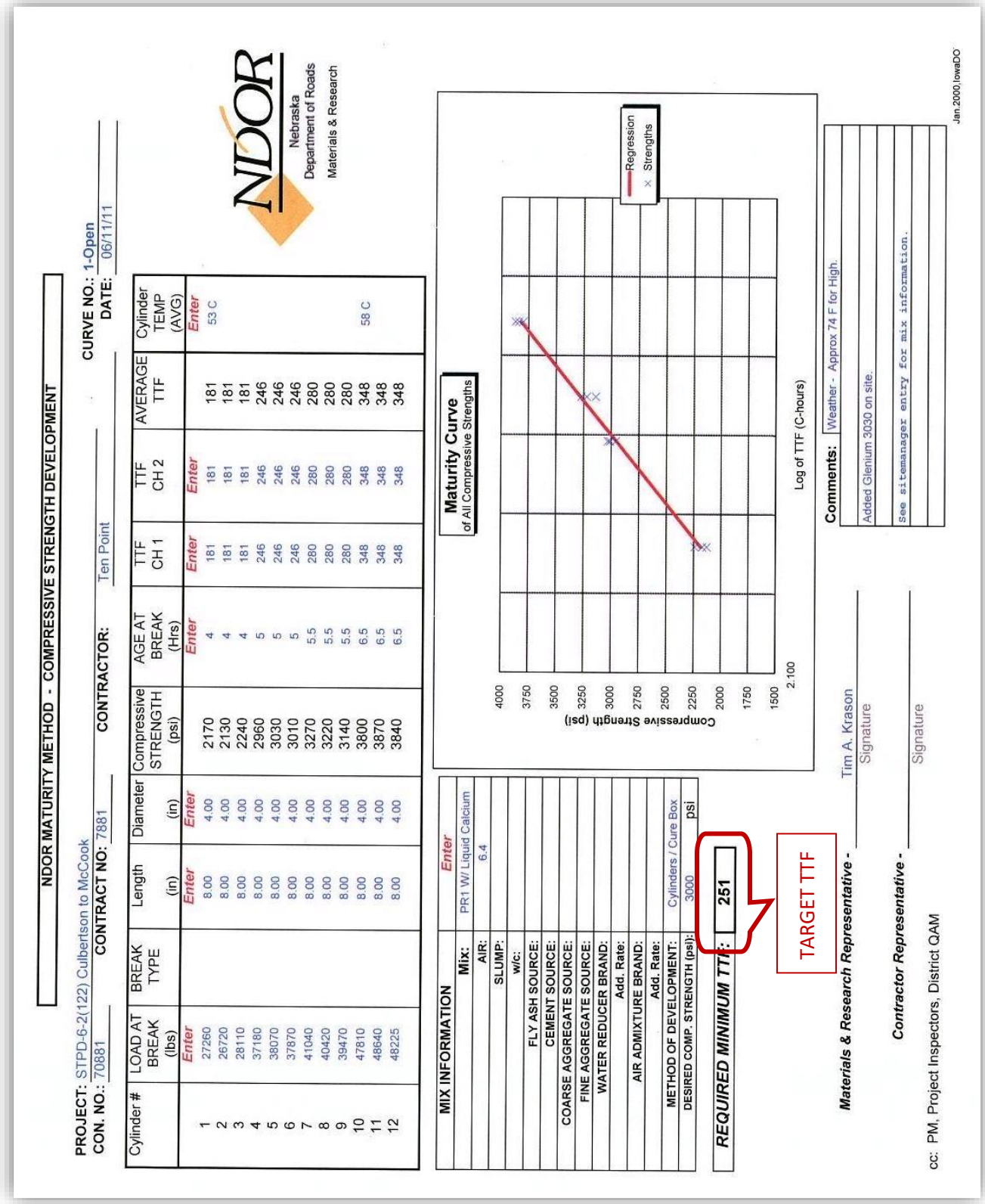
- For pavements/structures choose the AV Mainline Pavement/Structure Maturity Report – Field
- Click on Blue Carrot to right of "Test Result Value" to enter your test data.



- Test data is entered in this AV.
- For each additional wire or sensor click on New button to add an AV. Below are two entries.



Example – Maturity Curve for PR1 concrete. Target Opening TTF for 3000 psi



NDOR MATURITY METHOD - COMPRESSIVE STRENGTH DEVELOPMENT

PROJECT: STPD-6-2(122) Culbertson to McCook
CON. NO.: 70881 CONTRACT NO: 7881 CONTRACTOR: Ten Point CURVE NO.: 1-Open DATE: 06/11/11

Cylinder #	LOAD AT BREAK (lbs)	BREAK TYPE	Length (in)	Diameter (in)	Compressive STRENGTH (psi)	AGE AT BREAK (Hrs)	TTF CH 1	TTF CH 2	AVERAGE TTF	Cylinder TEMP (AVG)
	Enter		Enter	Enter		Enter	Enter	Enter		Enter
1	27260		8.00	4.00	2170	4	181	181	181	53 C
2	26720		8.00	4.00	2130	4	181	181	181	
3	28110		8.00	4.00	2240	4	181	181	181	
4	37180		8.00	4.00	2960	5	246	246	246	
5	38070		8.00	4.00	3030	5	246	246	246	
6	37870		8.00	4.00	3010	5	246	246	246	
7	41040		8.00	4.00	3270	5.5	280	280	280	
8	40420		8.00	4.00	3220	5.5	280	280	280	
9	39470		8.00	4.00	3140	5.5	280	280	280	
10	47810		8.00	4.00	3800	6.5	348	348	348	58 C
11	48640		8.00	4.00	3870	6.5	348	348	348	
12	48225		8.00	4.00	3840	6.5	348	348	348	

MIX INFORMATION	Enter
Mix:	PR1 W/ Liquid Calcium
AIR:	6.4
SLUMP:	
w/c:	
FLY ASH SOURCE:	
CEMENT SOURCE:	
COARSE AGGREGATE SOURCE:	
FINE AGGREGATE SOURCE:	
WATER REDUCER BRAND:	
Add. Rate:	
AIR ADMIXTURE BRAND:	
Add. Rate:	
METHOD OF DEVELOPMENT:	Cylinders / Cure Box
DESIRED COMP. STRENGTH (psi):	3000 psi

REQUIRED MINIMUM TTF: 251

TARGET TTF

Maturity Curve
of All Compressive Strengths

Compressive Strength (psi)
4000
3750
3500
3250
3000
2750
2500
2250
2000
1750
1500

Regression
Strengths

2.100
Log of TTF (C-hours)

Comments: Weather - Approx 74 F for High.
Added Glenium 3030 on site.
See sitemanager entry for mix information.

Materials & Research Representative - Tim A. Krason
Signature

Contractor Representative - _____
Signature

cc: PM, Project Inspectors, District QAM

NDOR Nebraska Department of Roads Materials & Research

Jan.2000.IowaDOT

NDOR MATURITY METHOD - COMPRESSIVE STRENGTH DEVELOPMENT

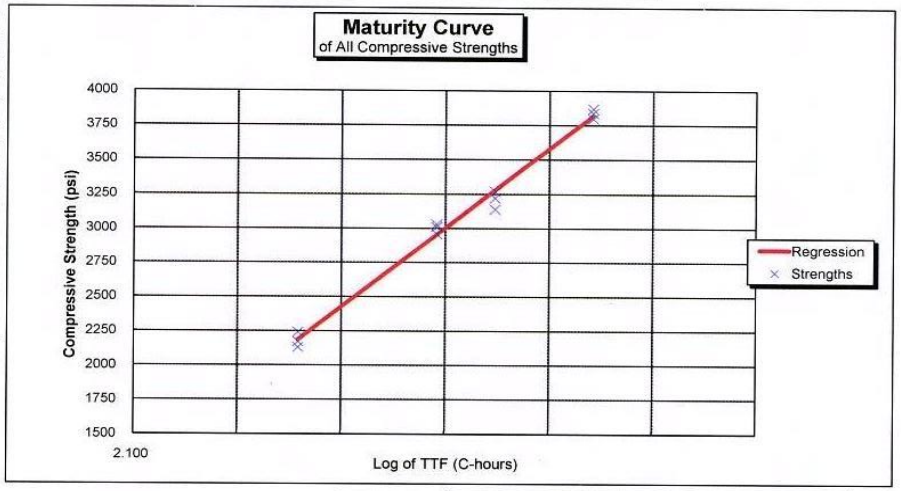
PROJECT: STPD-6-2(122) Culbertson to McCook
CON. NO.: 70881 **CONTRACT NO:** 7881 **CONTRACTOR:** Ten Point
CURVE NO.: 1-Acceptance **DATE:** 06/11/11

Cylinder #	LOAD AT BREAK (lbs)	BREAK TYPE	Length (in)	Diameter (in)	Compressive STRENGTH (psi)	AGE AT BREAK (Hrs)	TTF CH 1	TTF CH 2	AVERAGE TTF	Cylinder TEMP (AVG)
	Enter		Enter	Enter		Enter	Enter	Enter		Enter
1	27260		8.00	4.00	2170	4	181	181	181	53 C
2	26720		8.00	4.00	2130	4	181	181	181	
3	28110		8.00	4.00	2240	4	181	181	181	
4	37180		8.00	4.00	2960	5	246	246	246	
5	38070		8.00	4.00	3030	5	246	246	246	
6	37870		8.00	4.00	3010	5	246	246	246	
7	41040		8.00	4.00	3270	5.5	280	280	280	
8	40420		8.00	4.00	3220	5.5	280	280	280	
9	39470		8.00	4.00	3140	5.5	280	280	280	
10	47810		8.00	4.00	3800	6.5	348	348	348	58 C
11	48640		8.00	4.00	3870	6.5	348	348	348	
12	48225		8.00	4.00	3840	6.5	348	348	348	

Nebraska Department of Roads
Materials & Research

MIX INFORMATION	Enter
Mix:	PR1 W/ Liquid Calcium
AIR:	6.4
SLUMP:	
w/c:	
FLY ASH SOURCE:	
CEMENT SOURCE:	
COARSE AGGREGATE SOURCE:	
FINE AGGREGATE SOURCE:	
WATER REDUCER BRAND:	
Add. Rate:	
AIR ADMIXTURE BRAND:	
Add. Rate:	
METHOD OF DEVELOPMENT:	Cylinders / Cure Box
DESIRED COMP. STRENGTH (psi):	3500 psi

REQUIRED MINIMUM TTF: **307**



Materials & Research Representative - Tim A. Krason
Signature

Contractor Representative - _____
Signature

cc: PM, Project Inspectors, District QAM

Comments: Weather - Approx 74 F for High.
Added Glenium 3030 on site.
See sitemanager entry for mix information.

Jan.2000,IowaDO

Example – Maturity Curve for PR1 concrete. Target Acceptance TTF for 3500 psi

Example – Maturity Method – Field Data Sheet

This is a tool that may be used to calculate the TTF for you. It is more commonly used for mainline concrete placements. However it may be used for PR concrete as well.

This spreadsheet can be downloaded on your PC or Laptop. Contact Tim Krason for more information.

NDOT MATURITY METHOD - FIELD DATA SHEET

Project :	STP-39-3(123) Test Spreadsheet	**Curve #:**	1-47B3500 Slip Form
Control #:	12345 **Contract #:** 1345X	**Date Placed:**	7/2/2019
Contractor:	Harmon Construction	**Mix & Use:**	47B3500 Slip Form Paving

Target TTF Value For Acceptance : 3848

Target TTF Value For Opening or Form Removal : 2645

Section of Pavement to Open OR Structural Unit for Form Removal or Loading

Probe Station: 1234+00 **To Station:** 1238+10

Probe #	Date	Time	Age (hours)	Temp (deg C)	TTF at age (deg C-hr)	Sum TTF (deg C-hr)	Air Temp (deg C) (Optional)
1	07/02/19	08:00 AM	0.00	21		0	
	07/02/19	06:00 PM	10.00	33.2	371	371	
	07/03/19	06:30 AM	22.50	30.1	520.625	892	
	07/03/19	04:00 PM	32.00	27	366.225	1258	
	07/04/19	06:00 AM	46.00	22	483	1741	
	07/04/19	07:00 PM	49.00	28.3	105.45	1846	
	07/05/19	08:00 AM	62.00	23.7	468	2314	
	07/05/19	05:30 PM	71.50	27.9	340.1	2654	
	07/06/19	06:30 AM	84.50	21.8	453.05	3107	
	07/06/19	08:30 PM	98.50	26.3	476.7	3584	
	07/07/19	07:00 AM	109.00	21	353.325	3937	
					TTF	3937	

Probe Station: 1238+10 **To Station:** 1244+90

Probe #							
2	07/02/19	10:00 AM	0.00	22		0	
	07/02/19	06:00 PM	8.00	31.4	293.6	294	
	07/03/19	06:30 AM	20.50	32.5	524.375	818	
	07/03/19	04:00 PM	30.00	28.3	383.8	1202	
	07/04/19	06:00 AM	44.00	22	492.1	1694	
	07/04/19	07:00 PM	47.00	28.3	105.45	1799	
	07/05/19	08:00 AM	60.00	23.7	468	2267	
	07/05/19	05:30 PM	69.50	27.9	340.1	2607	
	07/06/19	06:30 AM	82.50	21.8	453.05	3060	
	07/06/19	08:30 PM	96.50	26.3	476.7	3537	
	07/07/19	07:00 AM	107.00	21	353.325	3891	
					TTF	3891	

Probe Station: 1244+90 **To Station:** 1247+00

Probe #							
3	07/02/19	12:00 PM	0.00	24.8		0	
	07/02/19	06:00 PM	6.00	30.9	227.1	227	
	07/03/19	06:30 AM	18.50	33.9	530	757	
	07/03/19	04:00 PM	28.00	29.8	397.575	1155	
	07/04/19	06:00 AM	42.00	22	502.6	1657	
	07/04/19	07:00 PM	45.00	28.3	105.45	1763	
	07/05/19	08:00 AM	58.00	23.7	468	2231	
	07/05/19	05:30 PM	67.50	27.9	340.1	2571	
	07/06/19	06:30 AM	80.50	21.8	453.05	3024	
	07/06/19	08:30 PM	94.50	26.3	476.7	3501	
	07/07/19	07:00 AM	105.00	21	353.325	3854	
					TTF	3854	

Thermocouple Wire Preparation

Photo 1 illustration.

Strip off approximately one inch of insulation from the type T thermocouple wire.

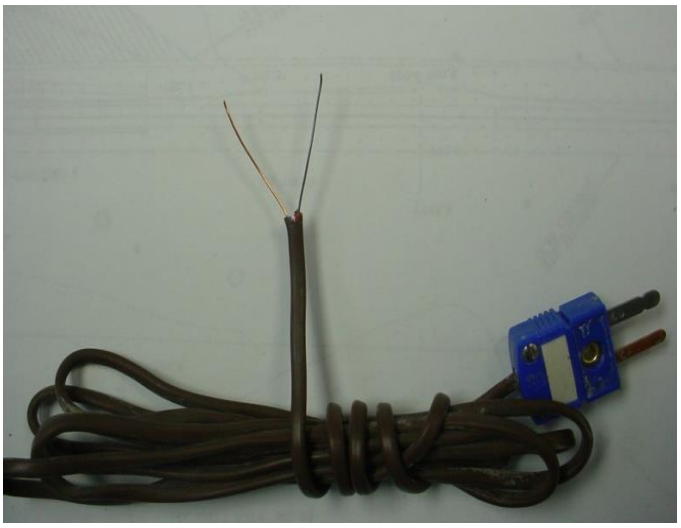


Photo 2 Illustration.

Twist the copper and nickel wires together. Be careful not to break the wires off at the edge of insulation.

The most common failure seems to occur at this point.

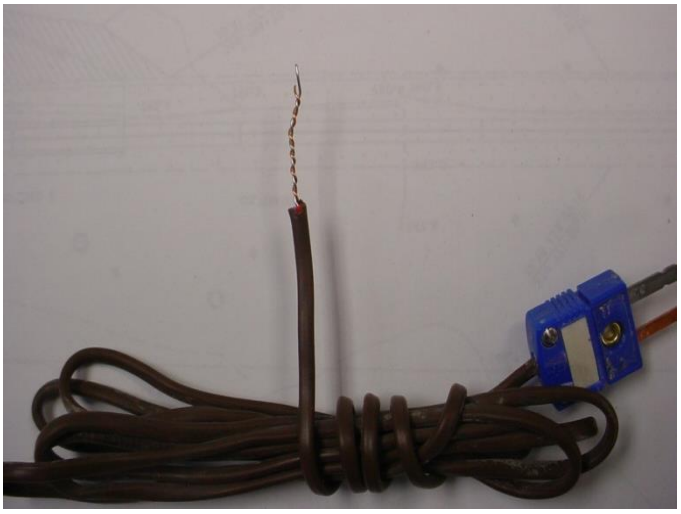
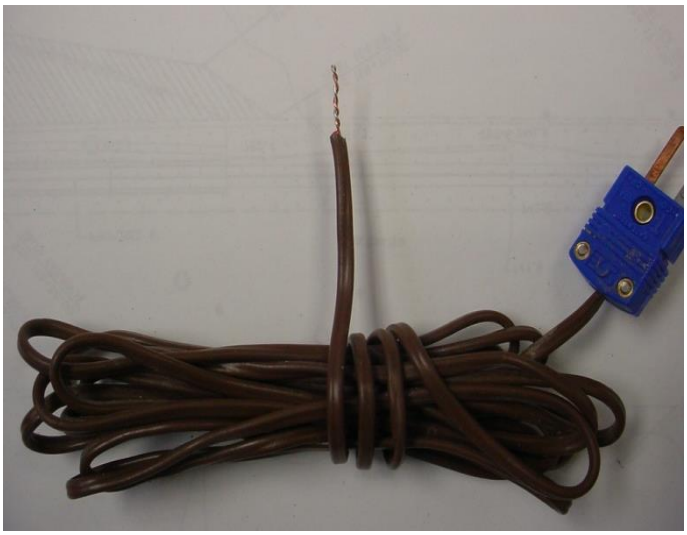


Photo 3 Illustration.

Snip the wire off so you have half an inch of exposure.



Examples of Instruments (Not limited too)