The Dynamic Cone Penetrometer “The DCP”

What is it, how does it work, and how can it help you?

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Presentation Objectives:

- What is it?
  - **Purpose & Concept**
  - **Parts**
- How does it work?
  - **Operation/Technique**
  - **Data Recording/Analysis**
- How can it help you?
  - **Layer Stiffness**
  - **Layer Thickness**
  - **Acceptance & Verification**
  - **Forensics**
  - **Correlations (CBR, Mr, etc.)**

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What is it?

- Purpose & Concept
  - **Dynamic Cone Penetrometer**
  - **Shallow Pavement Applications**
  - **Measures Stiffness, mm/blow**
  - **Simple Concept**
    - **Like hammering a nail**
    - **Stiff material requires more drops**
    - **Weak material requires fewer drops**
  - **Non Nuclear**
  - **Possible Method for Acceptance**
  - **Quick and Cost Effective**
  - **Another “Tool for the Toolbox”**

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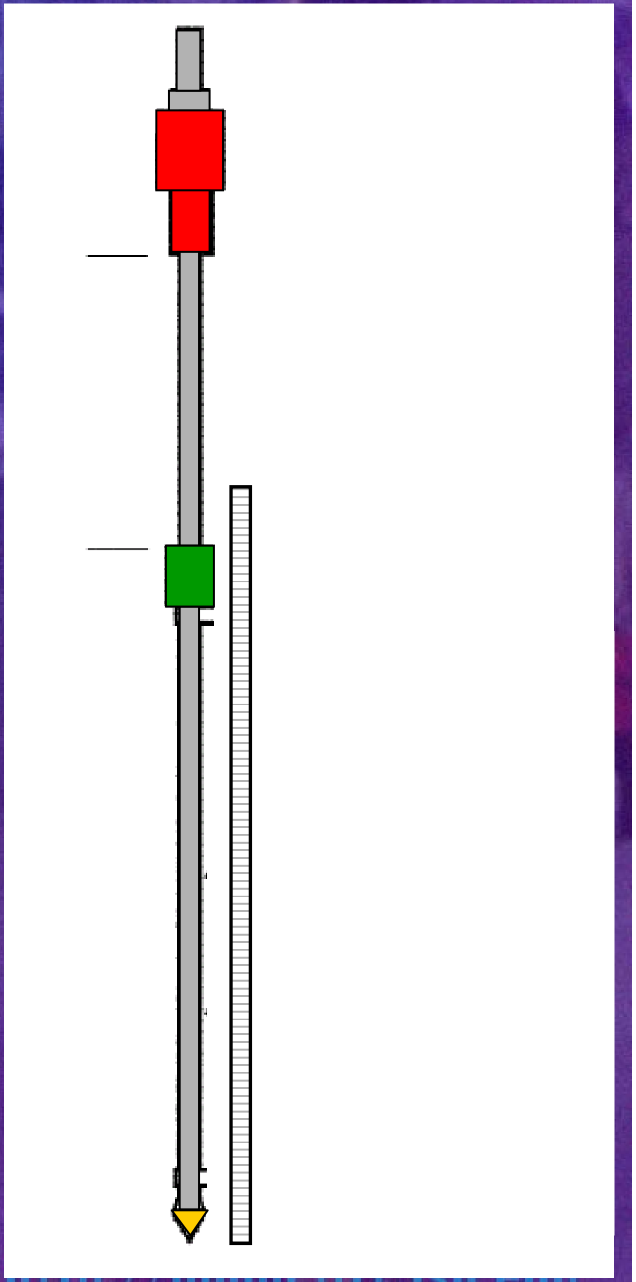
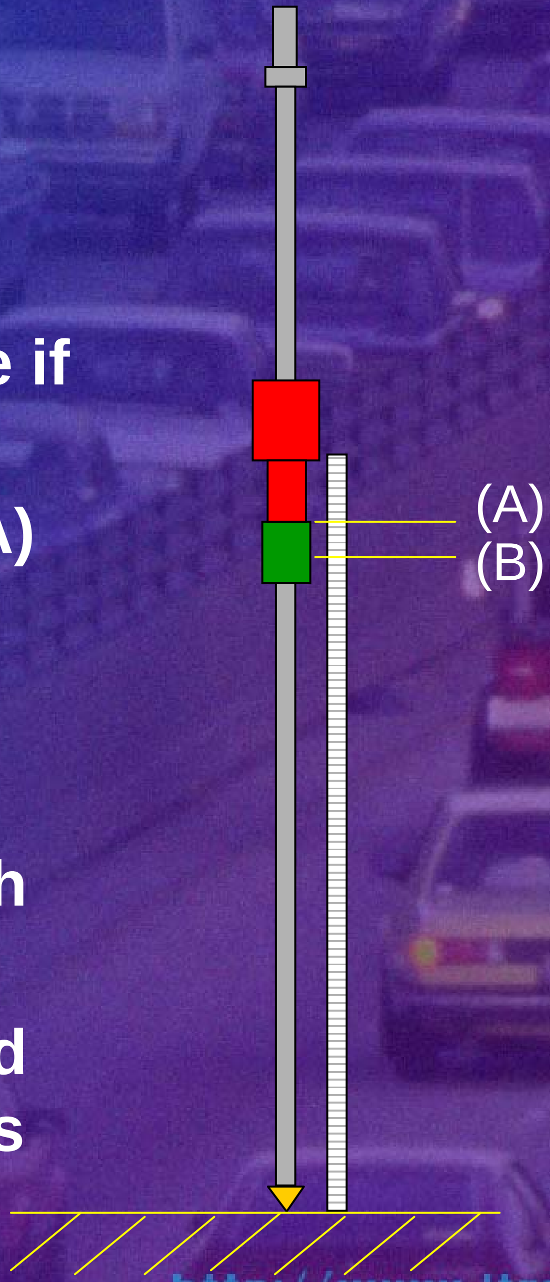
What is it?

- Parts
  - **Handle**
  - **Upper Rod (5/8” dia)**
  - **Hammer**
    - **17.8 pounds (8kg)**
    - **22.6 inch drop**
  - **Anvil & Lower Rod**
  - **Cone Tip (60 degree, ¾” dia)**
  - **Measuring Rod with cm & mm divs.**
  - **Other**
    - **Hammer Drill**
    - **Generator**
    - **Farm Jack**



How does it work?

- Operation
  - **Assemble DCP**
  - **Drill thru Asphalt or Concrete if necessary**
  - **Record reference readings (A)**
    - **Rod remains stationary**
  - **Lift hammer to handle**
  - **Release hammer**
  - **Record rod reading after each hammer drop (B)**
  - **Repeat drop, read, and record process thru pavement layers**



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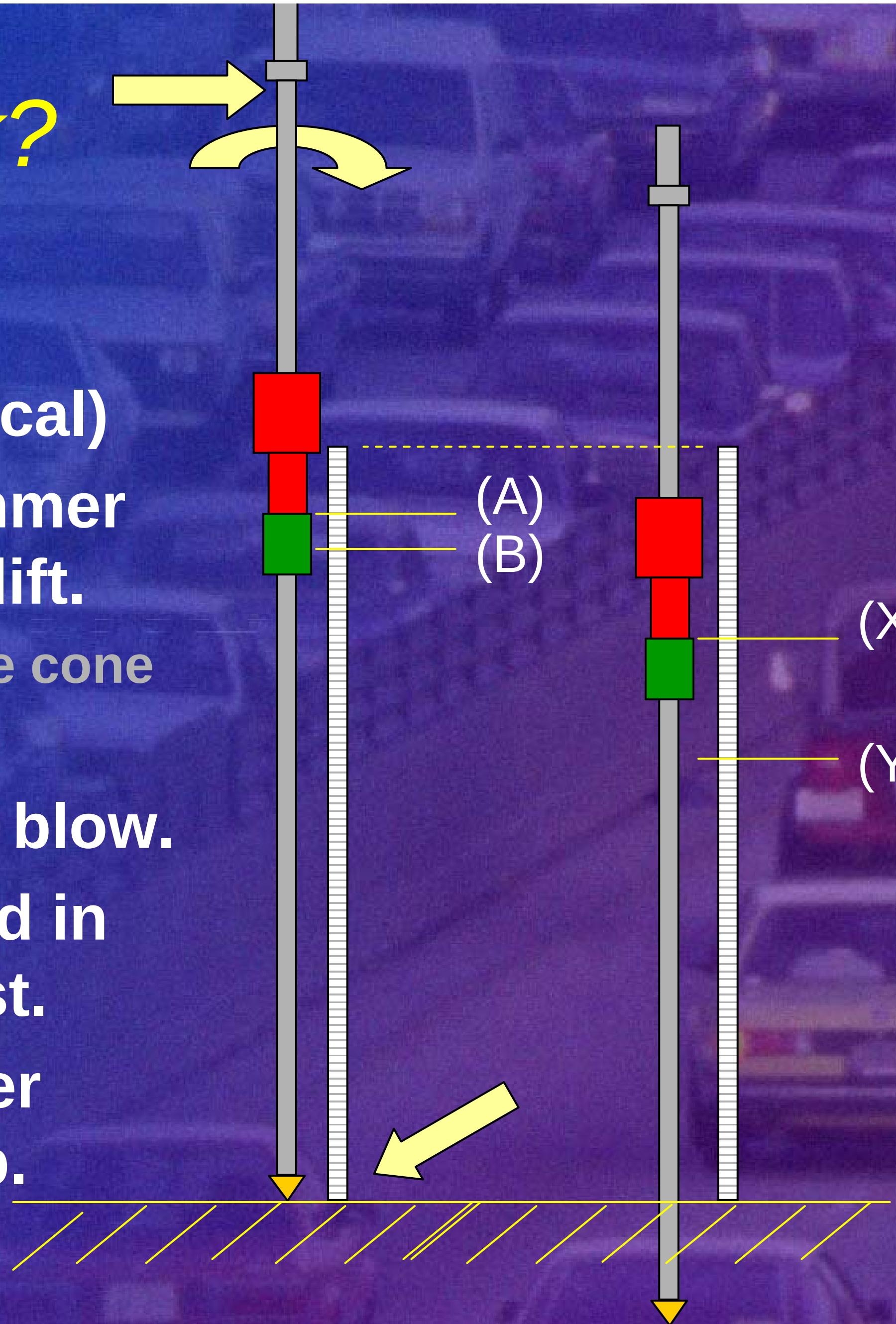
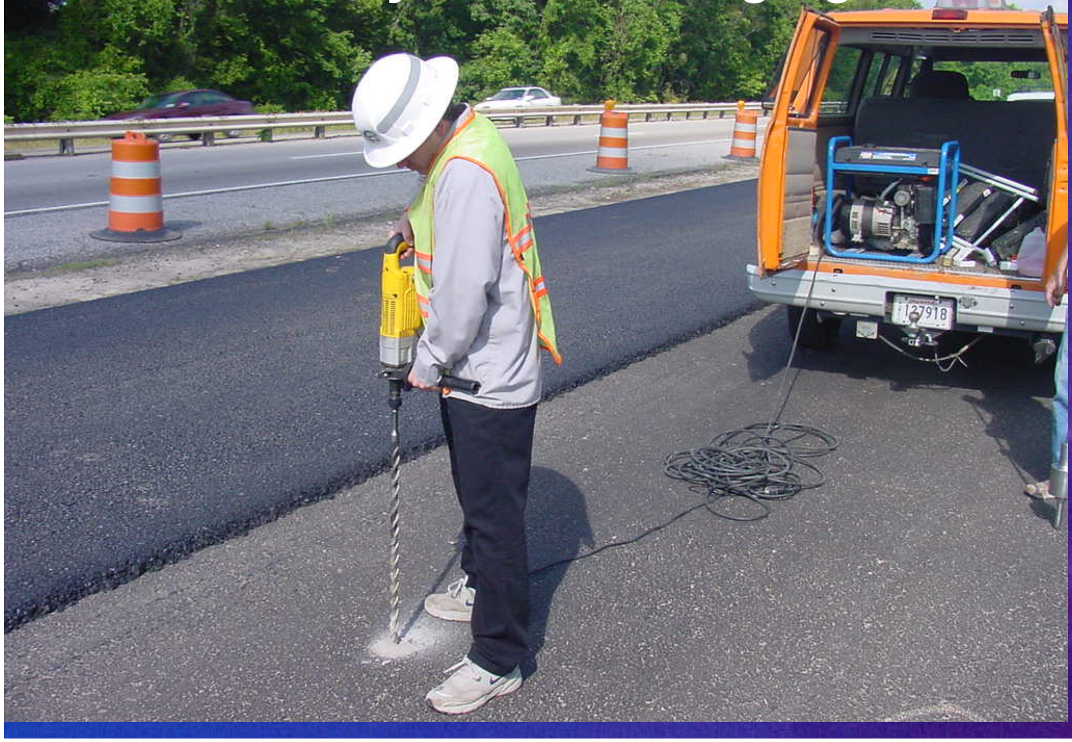
How does it work?

- Technique
  - **Keep straight (vertical)**
  - **Avoid banging hammer into handle during lift.**
    - **Can lose disposable cone**
    - **Damage to device**
  - **Spin rod after each blow.**
  - **Keep measuring rod in one spot during test.**
  - **Record reading after every hammer drop.**



How does it work?

- Operation (Prep & Planning)
  - **Hammer Drill**
    - **Quickly thru Asphalt or Concrete**
    - **Minimal Intrusion**
    - **Various Length bits**
    - **Dry vs wet coring rig**



  - **Crew Size**
    - **Hammer Operator**
    - **Reader**
    - **Recorder**

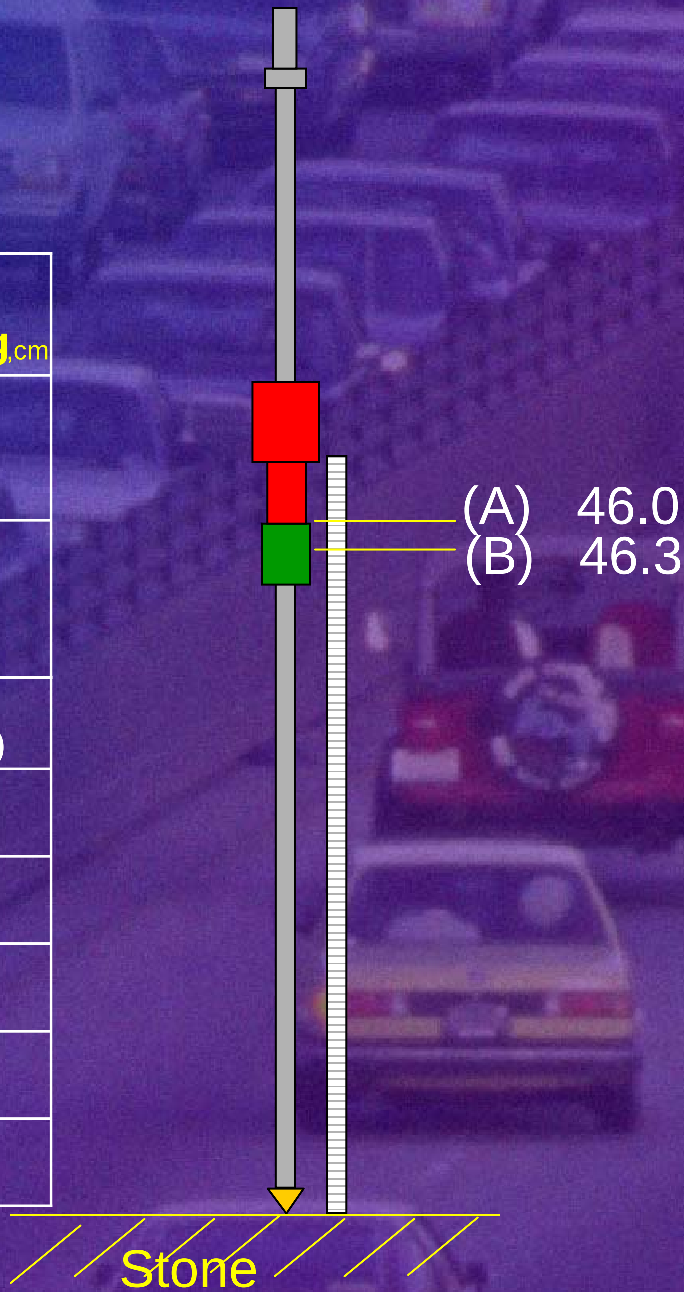
How does it work?

- Data Recording
  - **Project Information**
    - **Site Location**
    - **Station #**
    - **Distance from Centerline**
    - **Elevation (if available)**
  - **Pavement Information (as available)**
    - **Cross-Section Thickness Information**
    - **Material Types (classification and gradation)**
    - **Compaction Info (Proctor Moisture and Density) as available**
    - **Nuclear Gauge Information if available**

How does it work?

- Data Recording, example

Anytown, LA – Hwy 1, Sta. 19+00 RL	Blow #	Rod Reading, cm
Top of Asphalt/Concrete	0	NA
Top of Testing Surface (bottom of drilled hole, if applicable)	0	46.0 (A)
Reading after First Blow	1	46.3 (B)
Reading after Second Blow	2	46.6
Reading after Third Blow	3	46.9
Reading after Fourth Blow	4	47.2
Reading after Fifth Blow	5	47.5
Reading after Last Blow	?	???



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How does it work?

- Data Calculations (without drilling)

Blow #	Rod Reading, cm	Distance per Blow	Cumulative Penetration	Distance below Surface
0	NA	cm this times ten = DCPI	cm Running Total	cm can plot as inches or elev.
0	46.0	0.0	0.0	equal to tip location below surface
1	46.3	0.3	0.3	0.3
2	46.6	0.3	0.6	0.6
3	46.9	0.3	0.9	0.9
4	47.2	0.3	1.2	1.2
5	47.5	0.3	1.5	1.5
6	47.8	0.3	1.8	1.8

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How does it work?

- Data Calculations (drilling occurred)

Blow #	Rod Reading, cm	Distance per Blow	Cumulative Penetration	Distance below Surface
		cm	cm Running Total	cm can plot as inches or elev.
0	38.4			
0	46.0	7.6 Drilled depth	0.0	tip location below pavement surface
1	46.3	0.3	0.3	7.9
2	46.6	0.3	0.6	8.2
3	46.9	0.3	0.9	8.5
4	47.2	0.3	1.2	8.8
5	47.5	0.3	1.5	9.1
6	47.8	0.3	1.8	9.4

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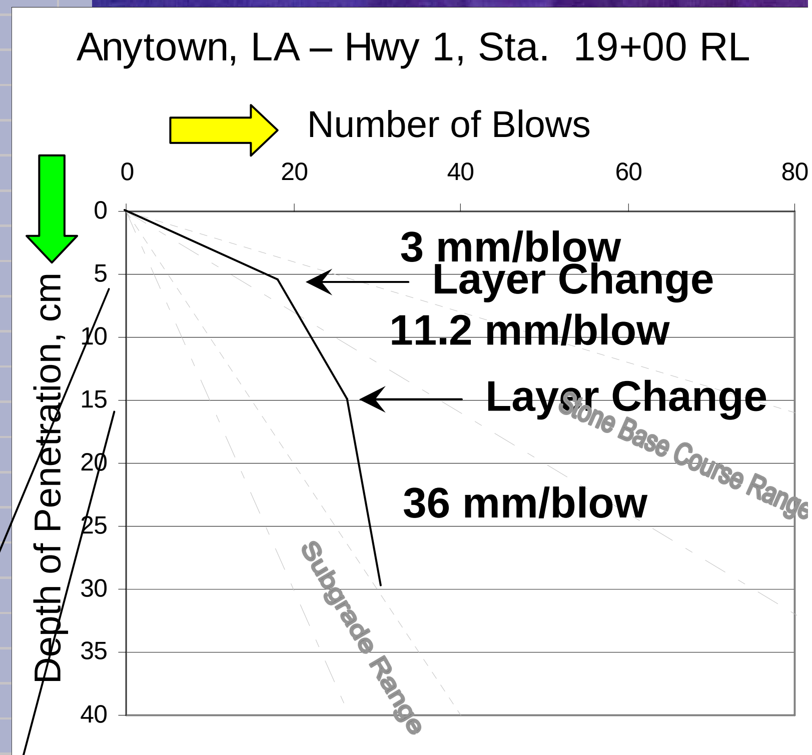
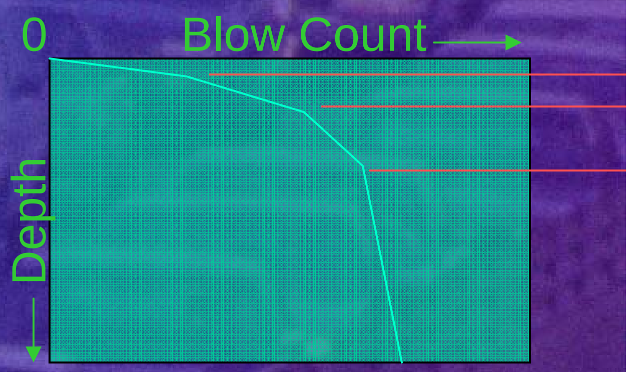
- Data Analysis
  - **Plotting Data**
  - **Layer Changes**
  - **Average mm/blow**

Example, cont'd

Station Number		19+00 RL			
Drilled Depth		0.0	Calculated		
	Blow #	Rod Reading, cm	Distance per blow, cm	Cumulative Penetration, cm	Depth below pavement surface
Top of Asphalt/Concrete	0	NA			
Top of Test Layer	0	46.0	0.0	0.0	0.0
After First Blow	1	46.3	0.3	0.3	0.3
	2	46.6	0.3	0.6	0.6
	3	46.9	0.3	0.9	0.9
	4	47.2	0.3	1.2	1.2
	5	47.5	0.3	1.5	1.5
	6	47.8	0.3	1.8	1.8
	7	48.1	0.3	2.1	2.1
	8	48.4	0.3	2.4	2.4
	9	48.7	0.3	2.7	2.7
	10	49.0	0.3	3.0	3.0
	11	49.3	0.3	3.3	3.3
	12	49.6	0.3	3.6	3.6
	13	49.9	0.3	3.9	3.9
	14	50.2	0.3	4.2	4.2
	15	50.5	0.3	4.5	4.5
	16	50.8	0.3	4.8	4.8
	17	51.1	0.3	5.1	5.1
	18	51.4	0.3	5.4	5.4
	19	52.0	0.6	6.0	6.0
	20	53.2	1.2	7.2	7.2
	21	54.4	1.2	8.4	8.4
	22	55.6	1.2	9.6	9.6
	23	56.8	1.2	10.8	10.8
	24	58.0	1.2	12.0	12.0
	25	59.2	1.2	13.2	13.2
	26	60.4	1.2	14.4	14.4
	27	64.0	3.6	18.0	18.0
	28	67.6	3.6	21.6	21.6
	29	71.2	3.6	25.2	25.2
	30	74.8	3.6	28.8	28.8



How can it help you?



Advantages:

- **Determines Stiffness in mm/blow**
- **Plotted slope = Stiffness in mm/blow**
  - **Flatter Slopes indicate stiffer layers**
  - **Steeper Slopes indicate weak layers**
- **Layer Changes identified by Slope Changes**
  - **Thicknesses can be determined/verified**
  - **Weak layers identified**
- **Minimal disturbance**
- **Test lower pavement layers without removal of upper layers**
- **Test different materials (Stone, Sand, Clay, and Silt)**
- **Compare time differences or adjacent sites**

Disadvantages:

- **Not for use on large stone, shell, asphalt, and concrete**
- **Damage can occur (repetitive blows in very stiff & improper removal)**
- **Does not measure moisture content or density – measures stiffness**

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How can it help you?

- Advantages:
  - **Possibly another way to adjust pay, based on Stiffness of in-place layers**
  - **Non “Nuclear”**
  - **Not rocket science**
  - **Correlations to CBR, Mr, etc.**
  - **Another “tool for the toolbox”… spread the word**

  - **Simple reliable, cost-effective tool for shallow pavement applications**

LTRC Project: 06-4GT

This is a comprehensive follow-up study after four LTRC research projects on involving DCP applications.

Objectives:

- **Develop a comprehensive implementation plan of DCP with procedures that DOTD can use in its daily production**
- **Develop or modify current DOTD specifications to accommodate such changes.**

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ALF Lane 4

Base, Treated Subase, & Subgrade

Field & Laboratory Test Summary

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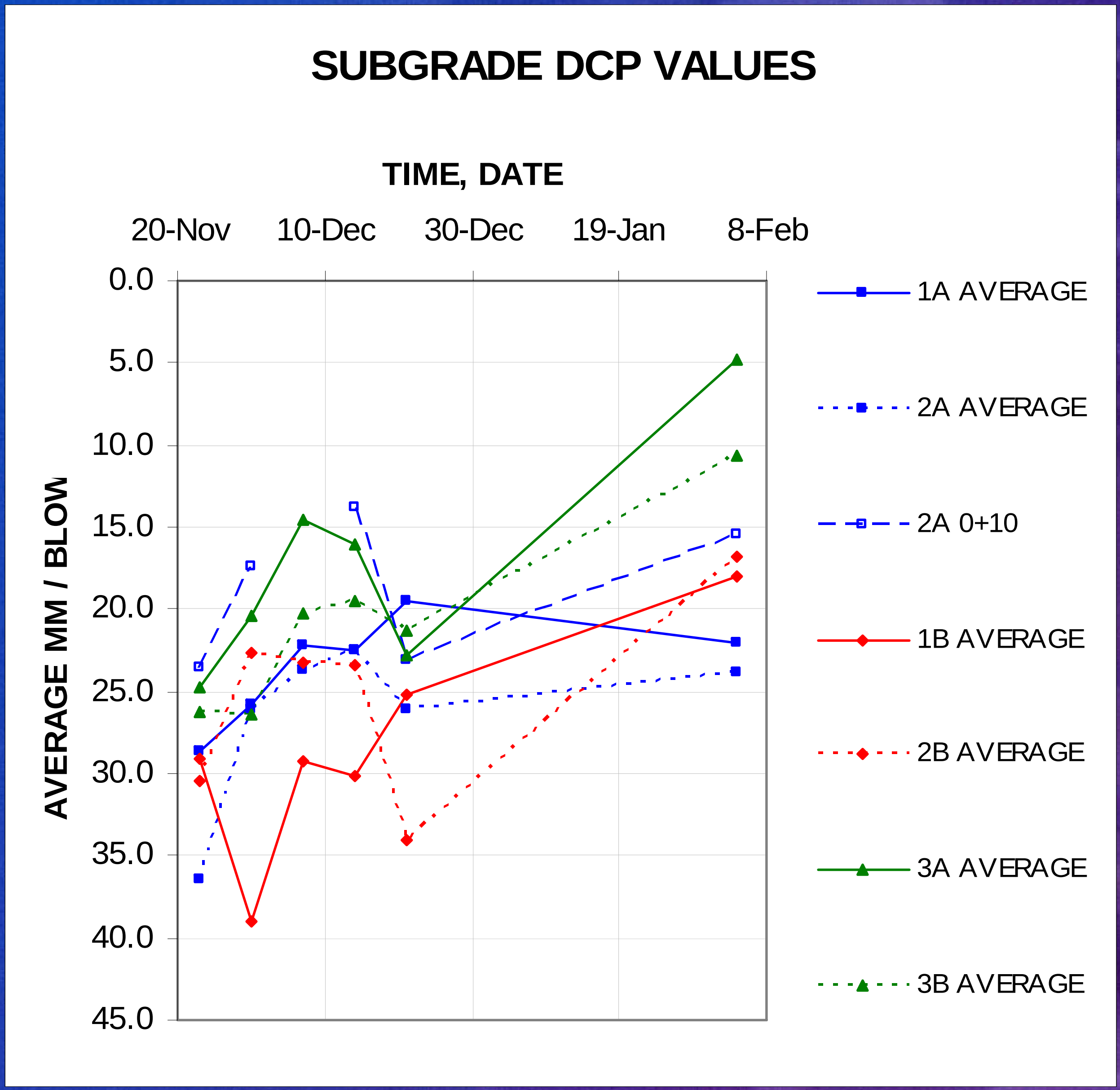
Cross-Section

- **Asphalt Surface (2”)**
- **Base (8.5”)**
  - Stone
  - BCS with 10% Slag
  - BCS with FlyAsh (small untreated area at end)
  - Foamed Asphalt
- **Treated Subbase (12”)**
  - Lime
  - Cement
- **Untreated Subgrade**

Construction ↑



November Average = 28.9

February Average = 13.6

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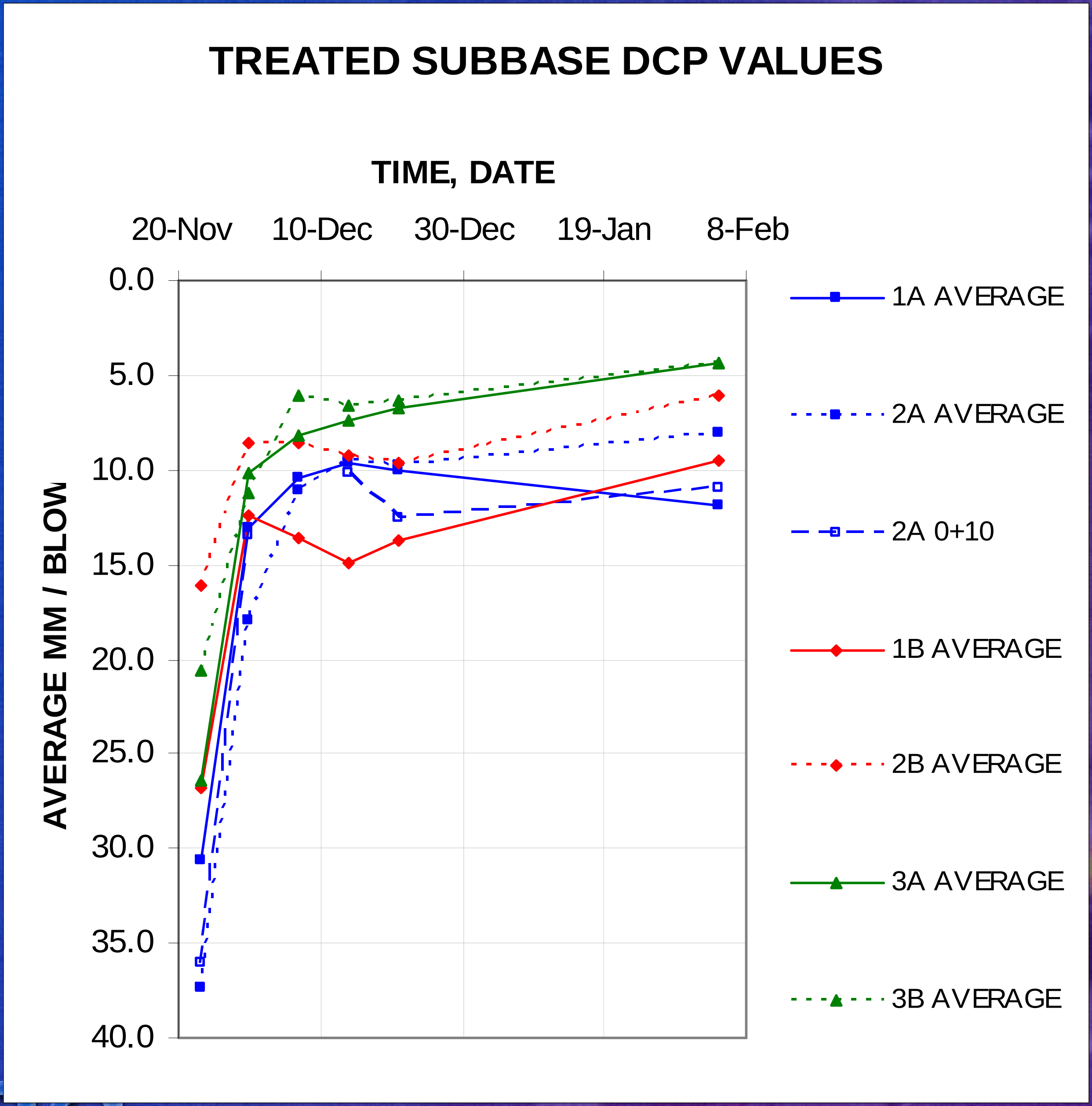
Cement Initial Average = 20.3

Lime Initial Average = 31.8



Cement Average = 5.3

Lime Average = 7.3

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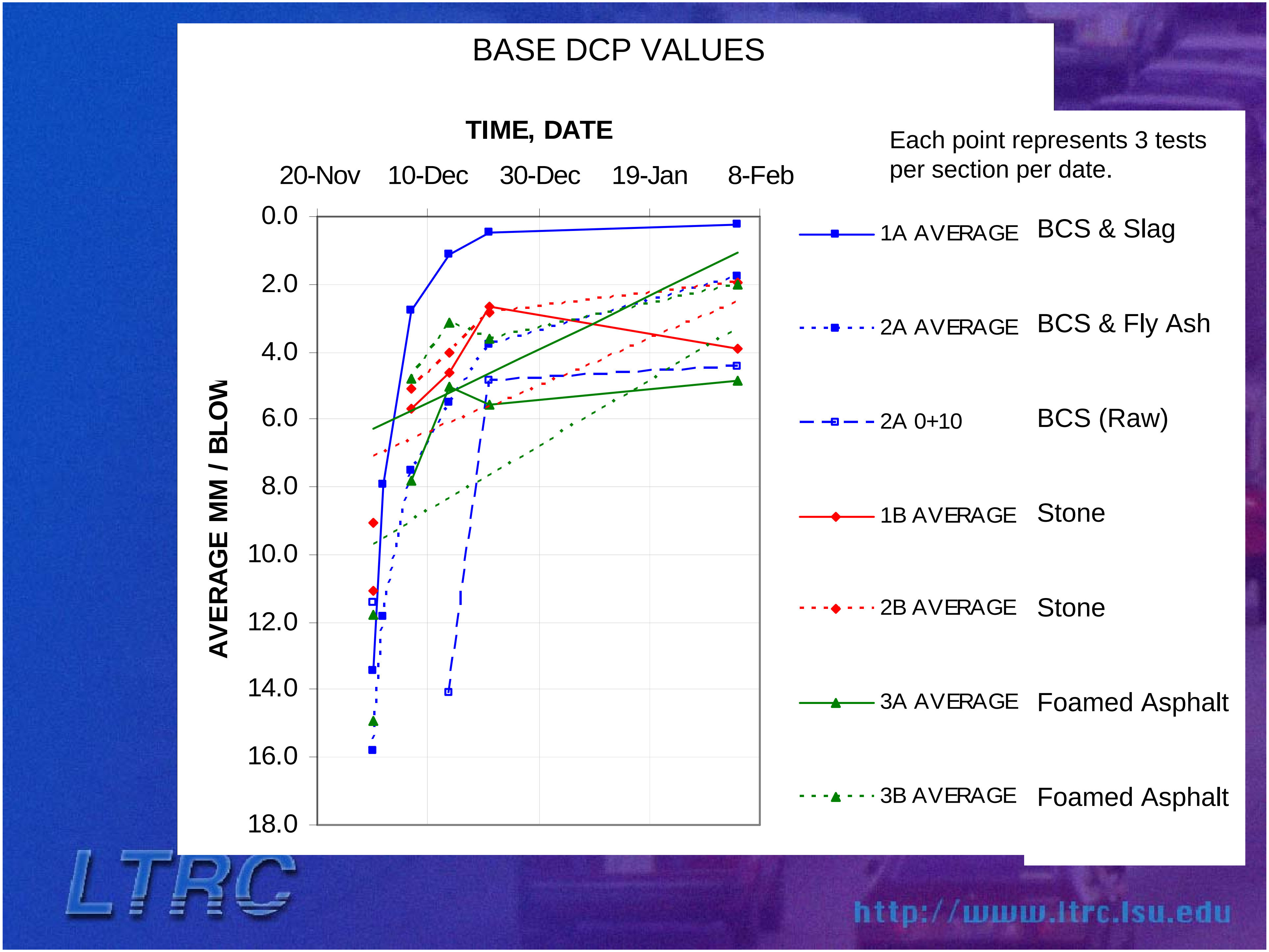

BASE DCP VALUES
TIME, DATE
20-Nov
10-Dec
30-Dec
19-Jan
8-Feb
AVERAGE MM / BLOW
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
Each point represents 3 tests per section per date.
1A AVERAGE BCS & Slag
2A AVERAGE BCS & Fly Ash
2A 0+10 BCS (Raw)
1B AVERAGE Stone
2B AVERAGE Stone
3A AVERAGE Foamed Asphalt
3B AVERAGE Foamed Asphalt
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Thanks!

- **Questions?**