# Session 53

## Nat Combass

FL. Dept. of Transportation D2

## *Surveying Technology Comparisons for Resurfacing Projects*

### Topic Description

This session will be a discussion of a test project performed in District 2, in which various types of technology were used to collect survey data necessary to determine cross slope information on resurfacing projects. We will discuss methods used and results.

### Speaker Biography

Nat Combass has been a Professional Surveyor and Mapper in the State of Florida since 1984, Mr. Combass has a total of 36 years of surveying experience, all with the District II Department of Transportation. He currently holds the position of District Location Surveyor, and is responsible for all in-house survey activities. His many years of experience have allowed him to be involved in and become very knowledgeable in all phases of route surveying and to experience many changes in survey technology.

# SURVEYING TECHNOLOGY FOR RESURFACING PROJECTS

A COMPARISON OF RESULTS AND COSTS

## PURPOSE

- COLLECT AND COMPARE DATA NECESSARY TO DETERMINE CROSS-SLOPE
- COMPARE DIFFERENT TECHNOLOGY
- COST PER MILE COMPARISON

# MAJOR REASONS FOR TEST

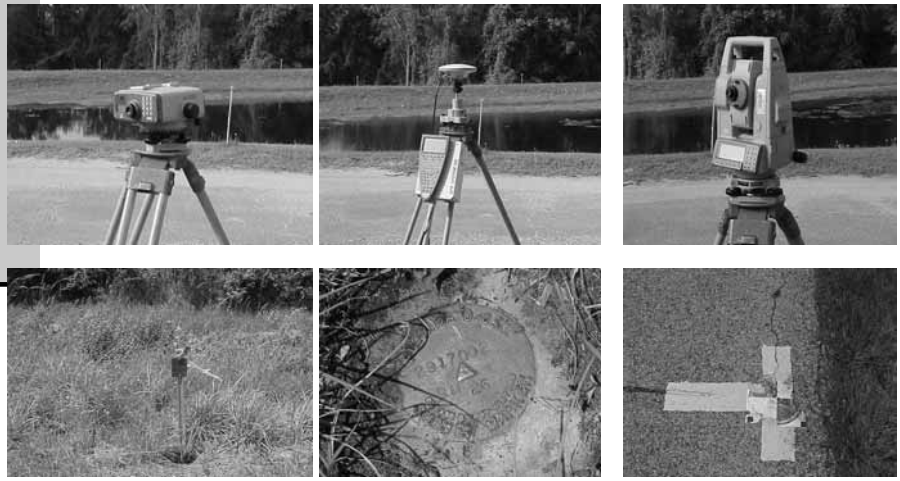
- CHANGES IN TECHNOLOGY
- SAFETY FOR SURVEYORS
- ESCALATING SURVEY COSTS

# OVERVIEW OF PROJECT

- I-10 COLUMBIA COUNTY
- 3.2 MILES LONG
- WESTBOUND ROADWAY
- RURAL SECTION
- HAS CURVES AND TANGENT SECTIONS

# CONTROLLING FACTORS

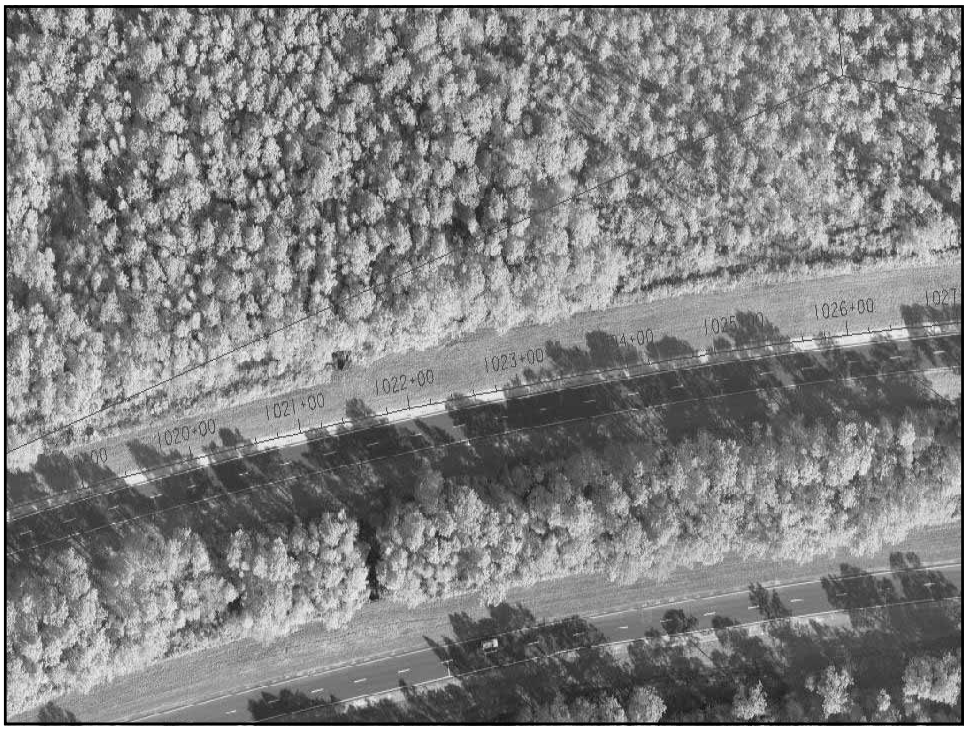
- HORIZONTAL AND VERTICAL CONTROL



# CONTROLLING FACTORS

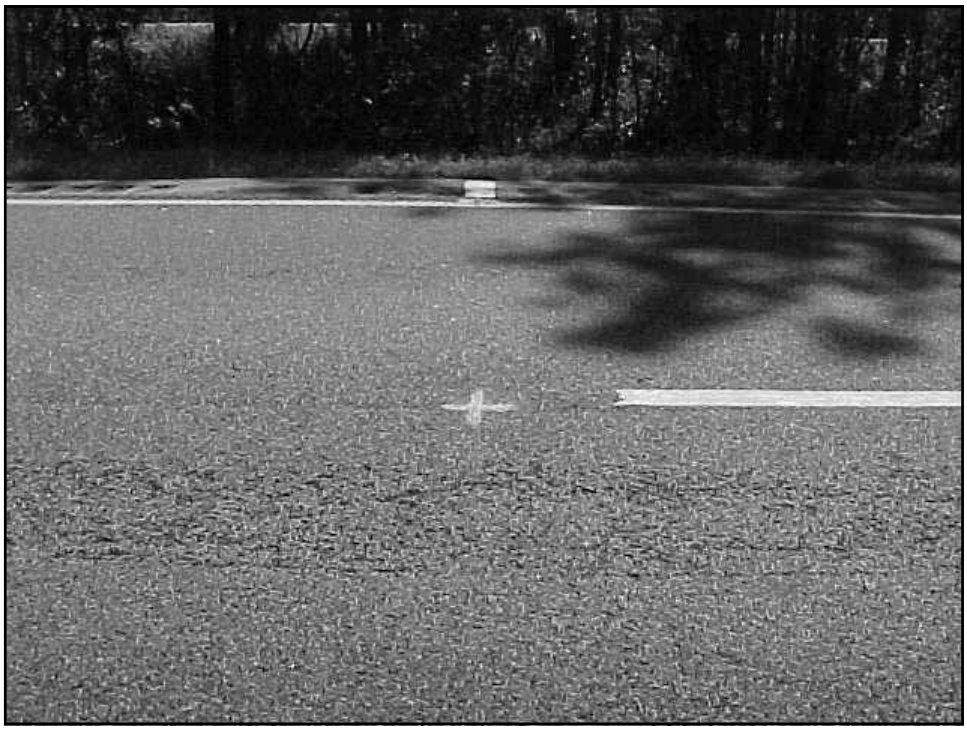
- HORIZONTAL AND VERTICAL CONTROL
- BASELINE

PC 921+50.982
921+00
922+00
923+00
924+00
925+00


1020+00
1021+00
1022+00
1023+00
1026+00

# CONTROLLING FACTORS

- HORIZONTAL AND VERTICAL CONTROL
- BASELINE
- PAINT MARKS



# METHODS AND TECHNOLOGIES USED

## CONVENTIONAL LEVEL & LEVEL ROD

# PRISMLESS TOTAL STATION

# LOW ALTITUDE AERIAL MAPPING (LAMP)

- USES HELICOPTER FOR AERIAL MAPPING
- FLOWN AT LOWER ALTITUDE (300’)
- ADVANTAGES
  - SAFETY
  - ACCURACY

## PAVESMART SURVEY PROFILER

- USES VEHICLE MOUNTED SENSORS TO GATHER SURFACE DEVIATION AND CROSS-SLOPE DATA
- DATA IS COLLECTED CONTINUOUSLY AT SPEEDS UP TO 10 MPH
- DATA IS USED TO PRODUCE SURFACE PLOT

## ADVANTAGES OF PAVESMART

- ONE-PERSON OPERATION
- LIMITED CONTROL NECESSARY
- FAST – APPROXIMATELY 15-20 LANE MILES PER DAY

PaveSmart

# DIGITAL TERRAIN MODEL (DTM)

- MOST COMMON METHOD USED TODAY
- DATA COLLECTED USING TOTAL STATION AND PRISM
- PRISMLESS TECHNOLOGY ALSO UTILIZED

# FIXED WING AERIAL PHOTOGRAPHY

- PROJECT FLOWN AT 1000’
- NOT NORMALLY USED FOR THIS TYPE PROJECT

# RESULTS

## I-10 TEST PROJECT COMPARISON TABLE I

| BASELINE STATION | POINT NAME | OFFSET RIGHT | CONV. LEVEL | TOTAL STATION PRISMLESS ELEV | LOW LEVEL AERIAL PHOTO | PAVESMART | DTM | FIXED WING AERIAL PHOTO BW 1000 |
|---|---|---|---|---|---|---|---|---|
| 922+00 | EPL48 | 7.073 | 153.06 | 153.10 | 153.15 | | 153.07 | 152.93 |
| DIFFERENCE | | | 0.25 | 0.25 | 0.25 | 0.26 | 0.28 | 0.31 |
| 922+00 | CLP48 | 17.999 | 153.31 | 153.35 | 153.4 | | 153.35 | 153.24 |
| DIFFERENCE | | | 0.28 | 0.26 | 0.28 | 0.29 | 0.33 | 0.26 |
| 922+00 | EPR48 | 30.02 | 153.59 | 153.61 | 153.68 | | 153.58 | 153.5 |
| | | | | | | | | |
| 923+00 | EPL47 | 7.349 | 153.18 | 153.22 | 153.21 | | 153.18 | 153.09 |
| DIFFERENCE | | | 0.27 | 0.28 | 0.26 | 0.31 | 0.28 | 0.22 |
| 923+00 | CLP47 | 18.265 | 153.45 | 153.5 | 153.47 | | 153.46 | 153.31 |
| DIFFERENCE | | | 0.31 | 0.27 | 0.29 | 0.34 | 0.27 | 0.40 |
| 923+00 | EPR47 | 30.301 | 153.76 | 153.77 | 153.76 | | 153.73 | 153.71 |
| | | | | | | | | |
| 924+00 | EPL46 | 7.517 | 153.26 | 153.31 | 153.29 | | 153.27 | 153.15 |
| DIFFERENCE | | | 0.26 | 0.28 | 0.27 | 0.31 | 0.27 | 0.31 |
| 924+00 | CLP46 | 18.4 | 153.52 | 153.59 | 153.56 | | 153.54 | 153.46 |
| DIFFERENCE | | | 0.32 | 0.27 | 0.32 | 0.30 | 0.26 | 0.27 |
| 924+00 | EPR46 | 30.567 | 153.84 | 153.86 | 153.88 | | 153.8 | 153.73 |
| | | | | | | | | |
| 925+00 | EPL45 | 7.532 | 153.36 | 153.4 | 153.38 | | 153.35 | 153.34 |
| DIFFERENCE | | | 0.25 | 0.25 | 0.23 | 0.28 | 0.27 | |
| 925+00 | CLP45 | 18.647 | 153.61 | 153.65 | 153.61 | | 153.62 | No Data |
| DIFFERENCE | | | 0.20 | 0.18 | 0.19 | 0.24 | 0.16 | |
| 925+00 | EPR45 | 30.6 | 153.81 | 153.83 | 153.8 | | 153.78 | 153.72 |

# SKETCH 1

- DIFFERENCE “A” AS SHOWN IN COMPARISON TABLE IS THE DIFFERENCE FROM OUTSIDE EDGE OF PAVEMENT TO CENTER OF PAVEMENT.
- DIFFERENCE “B” AS SHOWN IN COMPARISON TABLE IS THE DIFFERENCE FROM CENTER OF PAVEMENT TO INSIDE EDGE OF PAVEMENT.

## I-10 TEST PROJECT COMPARISON TABLE II
## CROSS SLOPE PERCENTAGE COMPARISON

| BASELINE STATION | CONV. LEVEL | TOTAL STATION PRISMLESS ELEV | LOW LEVEL AERIAL PHOTO | PAVESMART | DTM | FIXED WING AERIAL PHOTO BW 1000 |
|---|---|---|---|---|---|---|
| 905+00 | 2.08 | 2.04 | 2.25 | | 2.08 | 2.08 |
| 910+00 | 2.04 | 2.00 | 2.17 | | 1.88 | 2.50 |
| 918+00 | 2.25 | 2.17 | 2.25 | | 2.04 | 1.70 |
| 919+00 | 2.21 | 2.12 | 2.25 | | 1.96 | 2.04 |
| 920+00 | 2.33 | 2.25 | 2.38 | 2.50 | 2.33 | 2.42 |
| 921+00 | 2.12 | 2.08 | 2.12 | 2.33 | 2.04 | 1.58 |
| 921+50.982 | 2.33 | 2.29 | 2.29 | | 2.08 | 2.29 |
| 922+00 | 2.21 | 2.12 | 2.21 | 2.29 | 2.54 | 2.37 |
| 923+00 | 2.42 | 2.29 | 2.29 | 2.71 | 2.29 | 2.62 |
| 924+00 | 2.42 | 2.29 | 2.46 | 2.54 | 2.21 | 2.42 |
| 925+00 | 1.88 | 1.79 | 1.75 | 2.17 | 1.79 | 1.58 |
| 930+00 | 2.75 | 2.67 | 2.75 | 3.04 | 2.79 | 2.88 |
| 935+00 | 2.00 | 1.88 | 1.95 | 2.21 | 2.12 | 1.54 |
| 940+00 | 2.08 | 2.04 | 2.17 | 2.50 | 1.88 | 1.92 |
| 945+00 | 2.21 | 2.04 | 2.21 | 2.33 | 1.88 | 2.42 |
| 946+00 | 1.79 | 1.71 | 1.71 | 2.04 | 1.58 | 1.75 |
| 947+00 | 1.88 | 1.83 | 1.92 | 2.21 | 1.71 | 2.17 |
| 948+00 | 2.25 | 2.12 | 2.25 | 2.54 | 2.21 | 2.62 |
| 948+70.255 | 1.92 | 1.88 | 1.92 | | 1.88 | 2.08 |
| 949+00 | 1.75 | 1.71 | 1.83 | 2.08 | 1.75 | 1.88 |
| 950+00 | 1.79 | 1.67 | 1.75 | 2.17 | 1.79 | 1.83 |
| 951+00 | 2.29 | 2.17 | 2.25 | 2.75 | 2.12 | 2.00 |
| 952+00 | 2.29 | 2.17 | 2.54 | 2.75 | 2.17 | 2.33 |

# AVERAGE ELEVATION DIFFERENCE

## (COMPARED TO DIFFERENTIAL LEVELING)

| | PRISMLESS | LAMP | DTM | FIXED WING |
|---|---|---|---|---|
| EPL | 0.03 | 0.01 | -0.04 | -0.11 |
| CLP | 0.045 | 0.028 | -0.002 | -0.10 |
| EPR | 0.016 | 0.016 | -0.08 | -0.11 |

# ANALYSIS OF RESULTS

## BY: DR. RAY HINTZ

(1) I treated diff. lev. as correct and compared everything to it.

(2) I computed average of all differences (should get very close to zero if random error - same amount of plus and minus comparisons) to see if a systematic trend, none apparent except a little with Pavesmart. If they had a way to remove that trend they would obviously be more accurate.

Comparisons of Diff. Lev. elevation differences to

| | # comparsions | worst comp. | ave. comp. dev. |
|---|---|---|---|
| Prismless total station | 108 | 0.07 | -0.01 |
| Helicopter photogrammetry | 108 | 0.22 | 0.00 |
| Pavesmart | 88 | 0.14 | 0.03 |
| DTM | 108 | 0.14 | -0.01 |
| Fixed wing photogrammetry | 96 | 0.19 | 0.00 |

# comparisons - how many times comparison could be made

worst comparsion - absolute value of largest comparison

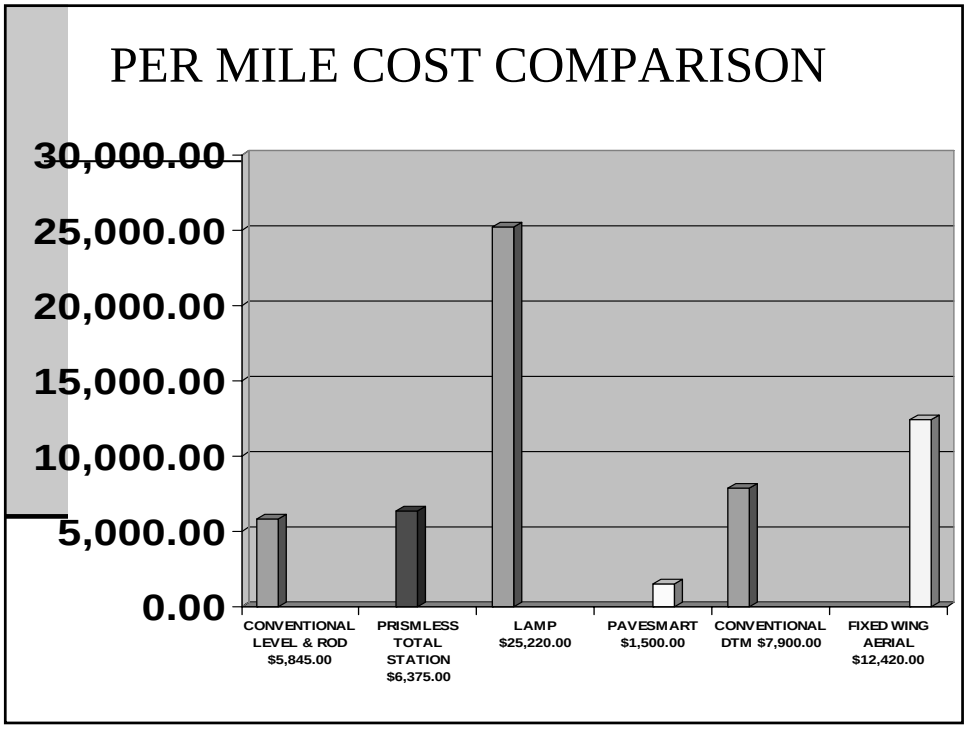
average comparsion - mean of comparison, if no systematic error this should be close to zero (only Pavesmart shows a systematic error trend)

Conclusions

Prismless total station and helicopter photogrammetry show the same Accuracies when compared to differential leveling.

While Pavesmart shows slightly larger inaccuracy compared to the previous Two techniques, the difference could be called insignificant, and if the Systematic error trend could be removed it would be similar in accuracy.

DTM and Fixed wing photogrammetry appear approximately twice as inaccurate as the other techniques but still useable for many engineering design accuracy requirements.


PER MILE COST COMPARISON
30,000.00
25,000.00
20,000.00
15,000.00
10,000.00
5,000.00
0.00
CONVENTIONAL LEVEL & ROD $5,845.00
PRISMLESS TOTAL STATION $6,375.00
LAMP $25,220.00
PAVESMART $1,500.00
CONVENTIONAL DTM $7,900.00
FIXED WING AERIAL $12,420.00