

2015 Annual Airport Conference



Federal Aviation
Administration

Random Sampling Techniques

Presented to: Airport Asphalt Pavement Workshop
By: Guillermo Felix, FAA
Date: March 3, 2015



Random Sampling technique

Section 6 of ERLPM



Random sampling rules

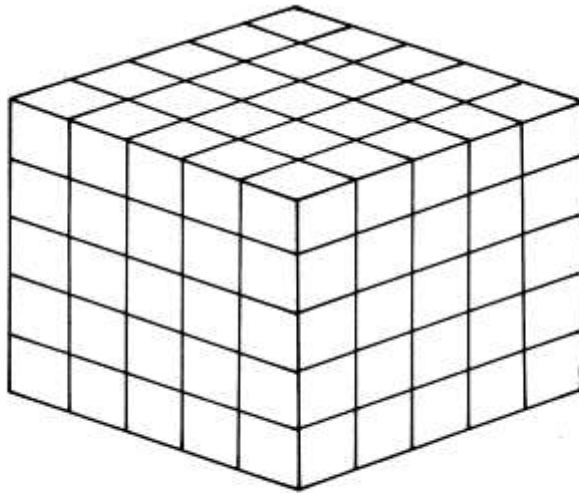
- **Philosophy for random sampling**
- **Material selection**
- **Size of production**
- **Partial production**
- **Sampling methods for plant produced material**
- **Sampling practice for field placed material**
- **Sampling joints**



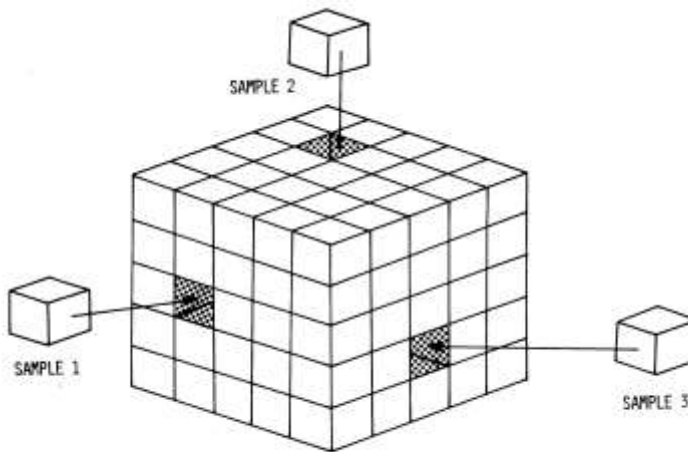
Considerations for Random sampling

- Same Materials
- Same Process
- Same Opportunity to be Selected





LOT



Example of Samples Selected from a Lot



Two processes for selecting as testing materials

- Testing material as produced by the plant:
there are two methods:
 - a) Selecting by time
 - b) Selecting by weight
- Testing material compacted in the field



Size/quantity of material to be tested

- *Plant produced material:*
 - a) *One Day's production ≤ 2000 Tons*
 - b) *Half Day's production when Day Production is $2000 < \text{Day} > 4000$ Tons*
- *Field Compacted material: the size generated by the plant produced material*



Sampling the lot

- *Divide Lot into 4 Equal sublots except for Test Strip were the lot is divided by 3*
- *Take sample from each subplot*



What happen is production has to stop? – Partial lots

- *3-4 samples were taken, sublots Constitute a Lot*
- *1-2 sublots add to next day*
- *Next day production would have 3-6 sublots*



Sampling plant produced material

- *Sample by Time*
- *Sample by weight (Tonnage)*



Sampling by time - example

- *Production Duration 10 HRS*
- *Sublots: $10/4 = 2 \frac{1}{2}$ Hrs = 150 minutes*
- *Assuming trucks will leave every 10 Min.*
- *Increment $150 / 10 = 15$ trucks*
- *Form 15 numbered pieces and put them in a bowl*
- *Draw one per Sublot*
- *Sample the truck at time selected*



Sampling by weight - Example

- *Lot size 2000 Tons*
- *Assuming load on Trucks = 20 Tons*
- *Sublots size $2000/4 = 500$ Tons*
- *Increment $500/20 = 25$ trucks per subplot*
- *Form 25 numbered pieces and put them in a bowl*
- *Select one for each subplot*
- *Sample the selected truck*



Sampling field compacted material

- *Lot side equal to Plant Produced Material, however the Plant Produced Material may have 3-6 sublots*
- *Divide the lot into 4 sublots (regardless of the Plant Produced Material sublots)*
- *Use Random Sampling Table 1 on Pages 40/41 of ERLLM*
- *Form 28 Numbered Pieces*
- *Randomly select a number per lot*



Using random tables

- *Column A is the Sublot number*
- *Column B is the longitudinal factor used to identify location along the length of sublot*
- *Column C is the lateral factor used to identify location from referenced side of sublot*
- *If the same number is drawn, use the following set of 4*



| Col. No. 1 | | | Col. No. 2 | | | Col. No. 3 | | | Col. No. 4 | | | Col. No. 5 | | | Col. No. 6 | | | Col. No. 7 | | |
|------------|------|------|------------|------|------|------------|------|------|------------|------|------|------------|------|------|------------|------|------|------------|------|------|
| A | B | C | A | B | C | A | B | C | A | B | C | A | B | C | A | B | C | A | B | C |
| 15 | .033 | .576 | 05 | .048 | .879 | 21 | .013 | .220 | 16 | .089 | .716 | 17 | .024 | .363 | 30 | .030 | .901 | 12 | .029 | .384 |
| 21 | .101 | .300 | 17 | .074 | .156 | 30 | .036 | .853 | 10 | .102 | .330 | 24 | .060 | .032 | 21 | .096 | .190 | 18 | .112 | .284 |
| 23 | .129 | .916 | 18 | .102 | .191 | 10 | .059 | .746 | 14 | .111 | .925 | 26 | .074 | .639 | 10 | .100 | .161 | 20 | .114 | .848 |
| 30 | .158 | .434 | 06 | .105 | .357 | 25 | .061 | .954 | 28 | .127 | .840 | 07 | .167 | .512 | 29 | .133 | .388 | 03 | .121 | .456 |
| 24 | .177 | .397 | 38 | .179 | .447 | 29 | .062 | .507 | 24 | .132 | .271 | 28 | .194 | .776 | 24 | .138 | .062 | 13 | .178 | .640 |
| 11 | .202 | .571 | 26 | .187 | .844 | 18 | .087 | .887 | 19 | .285 | .899 | 03 | .219 | .166 | 20 | .168 | .564 | 22 | .209 | .421 |
| 16 | .204 | .012 | 04 | .188 | .482 | 24 | .105 | .849 | 01 | .326 | .037 | 39 | .264 | .264 | 22 | .232 | .933 | 16 | .221 | .311 |
| 08 | .208 | .418 | 02 | .208 | .377 | 07 | .139 | .139 | 30 | .334 | .928 | 11 | .282 | .262 | 14 | .339 | .217 | 29 | .233 | .356 |
| 19 | .211 | .798 | 03 | .214 | .402 | 01 | .175 | .441 | 22 | .403 | .295 | 14 | .379 | .994 | 01 | .375 | .195 | 28 | .364 | .941 |
| 29 | .233 | .070 | 07 | .248 | .080 | 23 | .196 | .873 | 05 | .421 | .282 | 13 | .394 | .403 | 06 | .277 | .475 | 11 | .387 | .199 |
| 07 | .260 | .073 | 15 | .248 | .831 | 26 | .240 | .981 | 13 | .451 | .212 | 06 | .410 | .157 | 02 | .396 | .497 | 02 | .336 | .992 |
| 17 | .262 | .308 | 29 | .261 | .087 | 14 | .255 | .374 | 02 | .461 | .023 | 13 | .438 | .700 | 26 | .311 | .144 | 13 | .393 | .488 |
| 25 | .271 | .180 | 30 | .302 | .883 | 06 | .310 | .043 | 06 | .487 | .539 | 22 | .433 | .635 | 05 | .351 | .141 | 19 | .437 | .655 |
| 06 | .202 | .672 | 21 | .318 | .088 | 11 | .316 | .653 | 08 | .497 | .396 | 21 | .472 | .824 | 17 | .370 | .811 | 24 | .466 | .772 |
| 01 | .409 | .606 | 11 | .376 | .936 | 13 | .324 | .585 | 25 | .503 | .893 | 03 | .488 | .110 | 09 | .388 | .484 | 14 | .531 | .014 |
| 13 | .507 | .693 | 14 | .430 | .814 | 12 | .351 | .373 | 15 | .394 | .603 | 01 | .325 | .222 | 04 | .410 | .073 | 09 | .562 | .678 |
| 02 | .375 | .654 | 27 | .438 | .676 | 20 | .371 | .535 | 27 | .420 | .894 | 12 | .561 | .780 | 25 | .471 | .530 | 06 | .601 | .573 |
| 18 | .591 | .318 | 08 | .467 | .203 | 08 | .409 | .495 | 21 | .629 | .841 | 08 | .632 | .508 | 13 | .486 | .779 | 10 | .612 | .839 |
| 20 | .610 | .821 | 09 | .474 | .138 | 16 | .445 | .740 | 17 | .691 | .383 | 18 | .668 | .271 | 15 | .515 | .867 | 26 | .673 | .112 |
| 12 | .631 | .397 | 10 | .492 | .674 | 03 | .494 | .929 | 09 | .708 | .689 | 30 | .736 | .634 | 23 | .567 | .798 | 23 | .738 | .770 |
| 27 | .651 | .381 | 13 | .499 | .892 | 27 | .543 | .387 | 07 | .709 | .012 | 02 | .763 | .252 | 11 | .618 | .502 | 21 | .733 | .614 |
| 04 | .661 | .933 | 19 | .511 | .520 | 17 | .633 | .171 | 11 | .714 | .049 | 23 | .804 | .140 | 28 | .636 | .148 | 30 | .738 | .851 |
| 22 | .692 | .089 | 23 | .591 | .770 | 02 | .699 | .073 | 23 | .720 | .695 | 23 | .828 | .425 | 27 | .650 | .741 | 27 | .763 | .363 |
| 05 | .779 | .346 | 20 | .604 | .730 | 19 | .702 | .934 | 03 | .748 | .413 | 10 | .843 | .627 | 16 | .711 | .508 | 07 | .780 | .534 |
| 09 | .787 | .173 | 24 | .654 | .330 | 22 | .816 | .802 | 20 | .781 | .602 | 16 | .898 | .849 | 19 | .778 | .812 | 04 | .818 | .187 |
| 10 | .818 | .837 | 12 | .728 | .533 | 04 | .838 | .166 | 26 | .830 | .384 | 06 | .903 | .327 | 07 | .804 | .673 | 17 | .837 | .353 |
| 14 | .895 | .631 | 16 | .753 | .344 | 15 | .904 | .116 | 04 | .843 | .002 | 09 | .912 | .382 | 08 | .806 | .952 | 05 | .854 | .818 |
| 26 | .912 | .376 | 01 | .806 | .134 | 28 | .949 | .742 | 12 | .884 | .982 | 27 | .933 | .162 | 18 | .841 | .414 | 01 | .867 | .133 |
| 28 | .920 | .163 | 22 | .878 | .884 | 09 | .974 | .046 | 29 | .926 | .700 | 20 | .970 | .582 | 12 | .918 | .114 | 08 | .915 | .538 |
| 03 | .945 | .140 | 25 | .939 | .162 | 05 | .977 | .494 | 16 | .931 | .601 | 19 | .973 | .327 | 03 | .992 | .399 | 25 | .975 | .384 |



Example of determination of cores locations

- From bowl with 28 numbered pieces, number 12 is Drawn
- From Column "A" Select Lines 01, 02, 03 and 04
- From column B: .320, .489, .542, .153
- From Column C: .212, .827, .352, .163



| Col. No. 8 | Col. No. 9 | | | Col. No. 10 | | | Col. No. 11 | | | Col. No. 12 | | | Col. No. 13 | | | Col. No. 14 | | | | |
|------------|------------|-------|-------|-------------|-------|-------|-------------|-------|-------|-------------|-------|-------|-------------|-------|----|-------------|------|----|------|------|
| A B C | A B C | A B C | A B C | A B C | A B C | A B C | A B C | A B C | A B C | A B C | A B C | A B C | A B C | A B C | | | | | | |
| 09 | .042 | .071 | 14 | .061 | .935 | 26 | .038 | .023 | 27 | .074 | .779 | 16 | .073 | .987 | 03 | .033 | .091 | 26 | .035 | .175 |
| 17 | .141 | .411 | 02 | .065 | .097 | 30 | .066 | .371 | 06 | .094 | .396 | 23 | .078 | .036 | 07 | .047 | .391 | 17 | .089 | .363 |
| 02 | .143 | .321 | 03 | .094 | .228 | 27 | .073 | .876 | 24 | .098 | .524 | 17 | .096 | .076 | 28 | .064 | .113 | 10 | .149 | .681 |
| 05 | .162 | .899 | 16 | .122 | .945 | 09 | .095 | .568 | 10 | .133 | .919 | 04 | .153 | .163 | 12 | .066 | .360 | 28 | .238 | .075 |
| 03 | .385 | .016 | 18 | .158 | .430 | 05 | .180 | .741 | 15 | .187 | .079 | 10 | .254 | .834 | 26 | .076 | .552 | 13 | .244 | .747 |
| 28 | .391 | .034 | 25 | .193 | .449 | 12 | .200 | .851 | 17 | .227 | .747 | 06 | .284 | .628 | 30 | .087 | .101 | 24 | .262 | .366 |
| 08 | .369 | .557 | 24 | .224 | .372 | 13 | .259 | .327 | 20 | .236 | .571 | 12 | .305 | .616 | 02 | .127 | .187 | 08 | .264 | .651 |
| 01 | .436 | .386 | 10 | .225 | .323 | 21 | .264 | .681 | 01 | .245 | .988 | 25 | .319 | .901 | 06 | .144 | .068 | 18 | .285 | .311 |
| 20 | .430 | .289 | 09 | .233 | .838 | 17 | .283 | .645 | 04 | .317 | .291 | 01 | .320 | .212 | 25 | .202 | .674 | 02 | .340 | .131 |
| 18 | .455 | .789 | 20 | .290 | .120 | 23 | .363 | .063 | 29 | .350 | .911 | 08 | .416 | .372 | 01 | .247 | .023 | 29 | .353 | .478 |
| 23 | .488 | .715 | 01 | .297 | .242 | 20 | .364 | .366 | 26 | .380 | .104 | 13 | .432 | .556 | 23 | .253 | .323 | 06 | .359 | .270 |
| 14 | .496 | .274 | 11 | .337 | .760 | 16 | .395 | .363 | 28 | .425 | .864 | 02 | .489 | .827 | 24 | .320 | .651 | 20 | .387 | .348 |
| 15 | .303 | .342 | 19 | .389 | .064 | 02 | .423 | .540 | 22 | .487 | .526 | 29 | .303 | .787 | 10 | .328 | .365 | 14 | .392 | .694 |
| 04 | .515 | .693 | 13 | .411 | .474 | 08 | .432 | .736 | 05 | .532 | .511 | 15 | .518 | .717 | 27 | .338 | .412 | 03 | .408 | .077 |
| 16 | .532 | .112 | 20 | .447 | .893 | 10 | .476 | .468 | 14 | .564 | .357 | 28 | .524 | .998 | 13 | .356 | .991 | 27 | .440 | .280 |
| 22 | .557 | .337 | 22 | .478 | .321 | 03 | .508 | .774 | 11 | .572 | .306 | 03 | .542 | .352 | 16 | .401 | .792 | 22 | .461 | .830 |
| 11 | .559 | .620 | 29 | .481 | .993 | 01 | .401 | .417 | 21 | .594 | .197 | 19 | .583 | .462 | 17 | .423 | .117 | 16 | .527 | .503 |
| 12 | .630 | .216 | 27 | .562 | .403 | 22 | .687 | .917 | 09 | .607 | .524 | 05 | .695 | .111 | 21 | .481 | .838 | 30 | .531 | .486 |
| 21 | .672 | .320 | 04 | .546 | .179 | 29 | .697 | .862 | 19 | .650 | .572 | 07 | .733 | .838 | 08 | .560 | .401 | 25 | .678 | .360 |
| 13 | .709 | .373 | 08 | .603 | .758 | 11 | .701 | .603 | 18 | .664 | .101 | 11 | .744 | .948 | 19 | .564 | .190 | 21 | .723 | .014 |
| 07 | .745 | .687 | 15 | .632 | .927 | 07 | .728 | .498 | 25 | .674 | .428 | 18 | .793 | .748 | 05 | .571 | .054 | 05 | .797 | .599 |
| 30 | .780 | .285 | 06 | .707 | .107 | 14 | .745 | .679 | 02 | .697 | .674 | 27 | .802 | .967 | 18 | .387 | .584 | 15 | .801 | .927 |
| 19 | .843 | .097 | 28 | .737 | .161 | 24 | .819 | .444 | 03 | .767 | .928 | 21 | .826 | .487 | 15 | .604 | .145 | 12 | .836 | .294 |
| 26 | .846 | .366 | 17 | .846 | .130 | 15 | .840 | .823 | 16 | .809 | .529 | 24 | .833 | .832 | 11 | .641 | .798 | 04 | .834 | .982 |
| 29 | .861 | .307 | 07 | .874 | .491 | 25 | .863 | .568 | 30 | .838 | .294 | 26 | .853 | .142 | 22 | .472 | .156 | 11 | .884 | .928 |
| 25 | .906 | .874 | 05 | .880 | .828 | 06 | .878 | .215 | 13 | .845 | .470 | 14 | .861 | .462 | 20 | .674 | .887 | 19 | .886 | .832 |
| 24 | .919 | .809 | 23 | .931 | .659 | 18 | .930 | .601 | 08 | .855 | .524 | 20 | .874 | .625 | 14 | .732 | .581 | 07 | .929 | .932 |
| 10 | .952 | .555 | 26 | .960 | .365 | 04 | .954 | .827 | 07 | .867 | .718 | 30 | .929 | .036 | 09 | .774 | .560 | 09 | .932 | .206 |
| 06 | .961 | .504 | 21 | .978 | .194 | 28 | .963 | .004 | 12 | .881 | .722 | 09 | .935 | .582 | 29 | .921 | .752 | 01 | .970 | .692 |
| 27 | .969 | .811 | 12 | .982 | .183 | 19 | .988 | .020 | 23 | .927 | .872 | 22 | .947 | .797 | 04 | .959 | .099 | 23 | .973 | .083 |



Pavement geometry

- Pavement Width - 12-1/2 Feet
- Select Reference Side (left)
- Divide lot length
- $1600/4 = 400$ Feet
- Samples to be taken no Closer Than 1 Foot from a Joint



Location of cores - subplot

Sublot 1

Length $400 \times .320 = 128'$

Width $12.5 \times .212 = 3'$

Sublot 2

Length $400 \times .489 = 196'$

Width $12.5 \times .827 = 10'$

Sublot 3

Length $400 \times .542 = 217'$

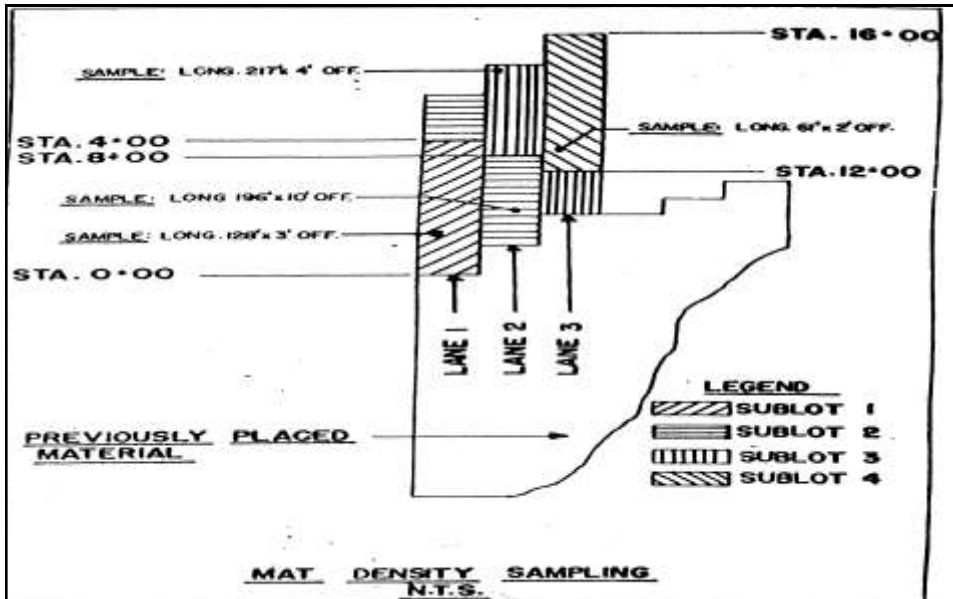
Width $12.5 \times .352 = 4'$

Sublot 4

Length $400 \times .153 = 61'$

Width $12.5 \times .163 = 2'$



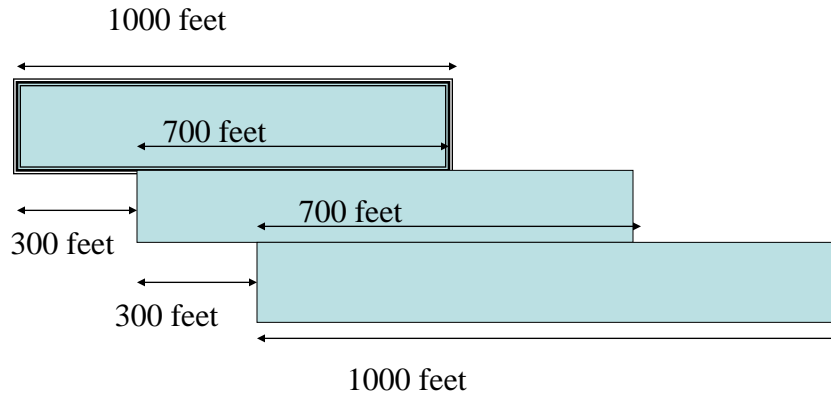


Location of cores for joint testing

- *Could be within same lot or abutting lots*
- *When within two different lots use the lowest specific gravity*
- *Divide length into 4 equal sublots*
- *Directly on the joint (error in P-403)*
- *Minimum diameter 5"*
- *Penalty on joint density*



Joint testing example

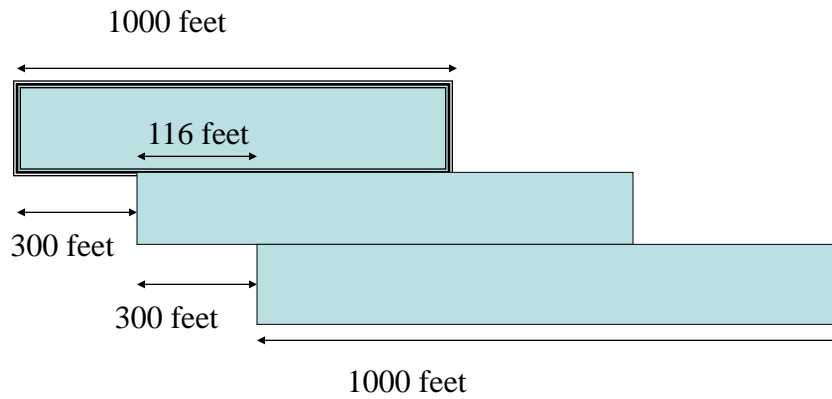


Location of cores for joint testing

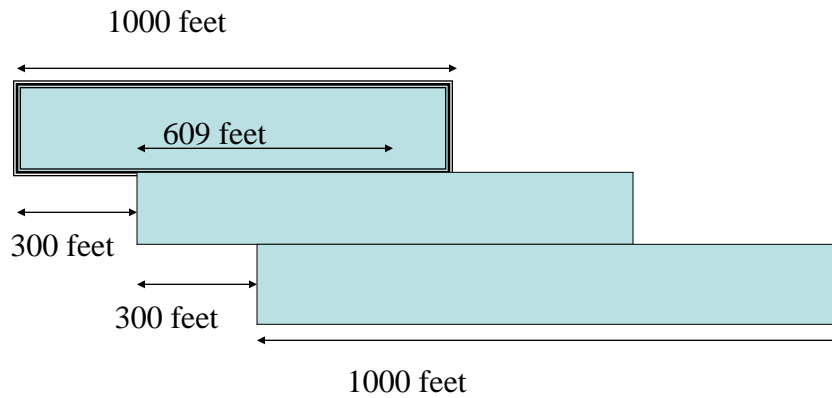
- *From the bowl with 28 numbered pieces we drawn number 16*
- *B values for column 16*
- *.331, .739, .548, .516*
- *Sublot 1; $350 \times 0.331 = 115.85 = 116'$*
- *Sublot 2; $350 \times 0.739 + 350 = 608.65 = 609'$*
- *Sublot 3; $350 \times 0.548 = 191.8 = 192'$*
- *Sublot 3; $350 \times 0.516 + 350 = 530.6 = 531'$*



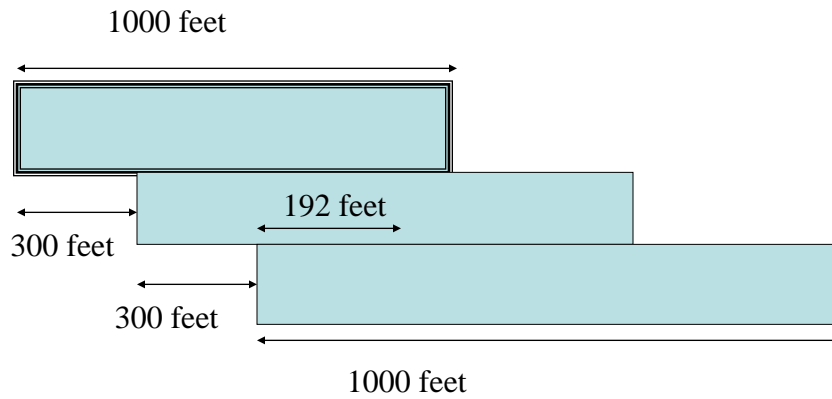
Joint testing



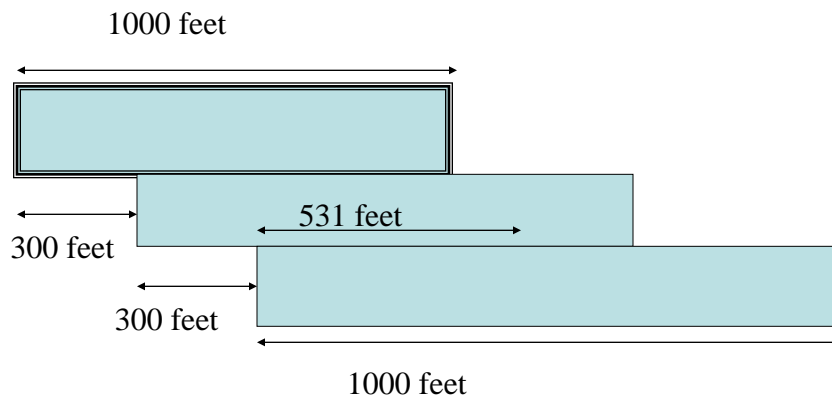
Joint testing



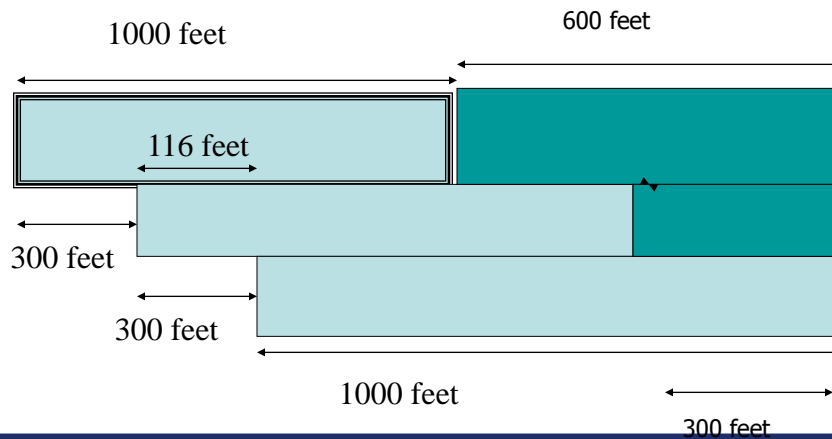
Joint testing



Joint testing



Joint testing – second lane



- Total Joint length
- $600 + 300 = 900$ feet
- $900/4 = 225$ feet
- Number 20 is selected
- Sublot 01 -.415
- Sublot 2 - .958
- Sublot 3 - .150
- Sublot 4 - .154



- Distances along the joint

- Sublot 1 $225 \times .415 = 93.38 = 93$

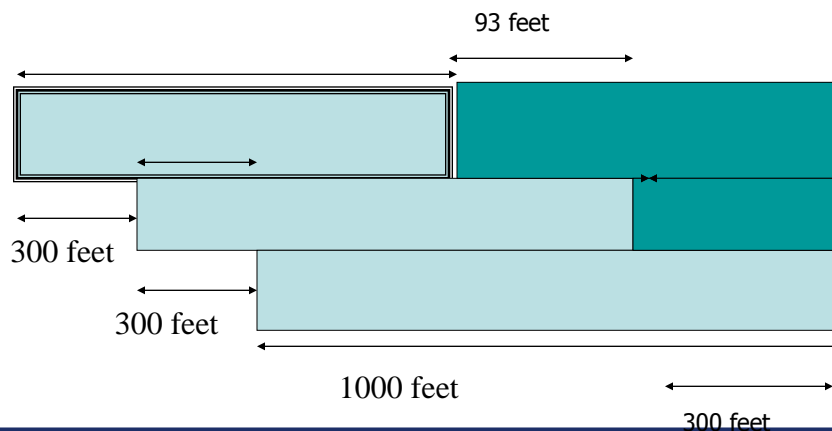
- Sublot 2 $225 \times .958 = 215.55 = 216$

- Sublot 3 $225 \times .150 = 33.75 = 34$

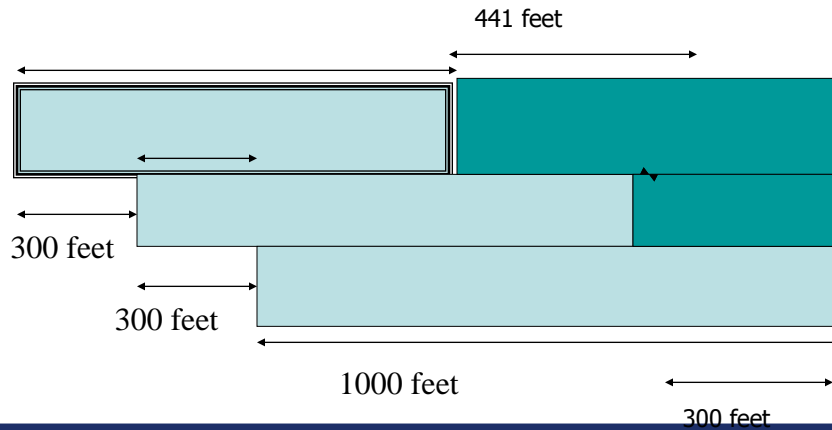
- Sublot 4 $225 \times 34.65 = 35$



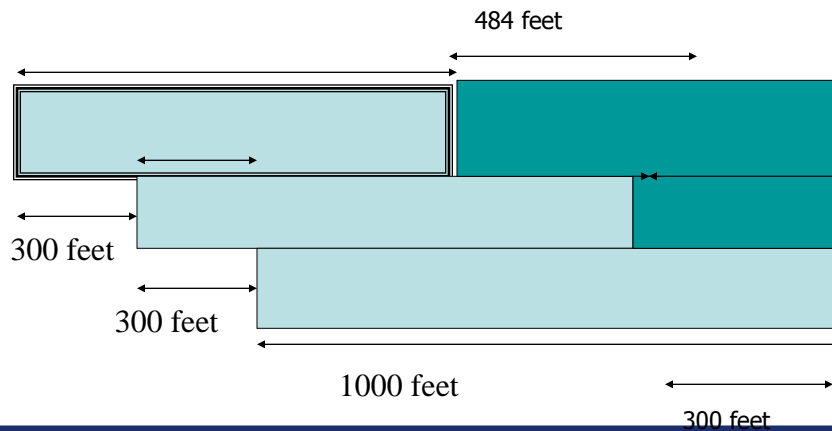
Joint testing – second lane



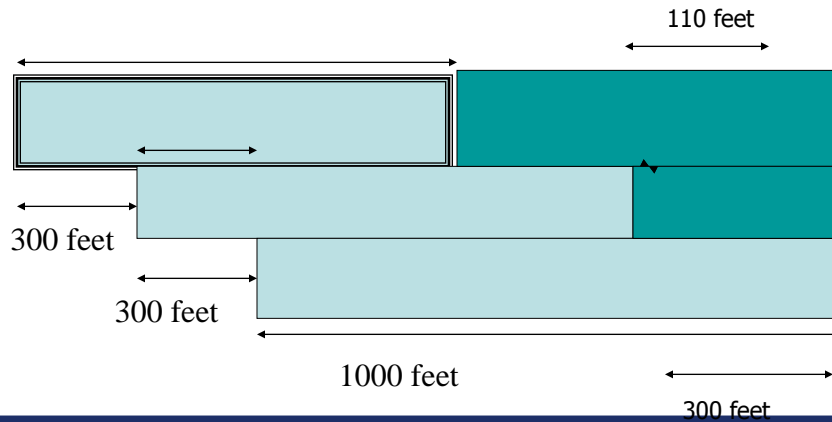
Joint testing – second lane



Joint testing – second lane



Joint testing – second lane



| IN-PLACE DENSITY ACCEPTANCE CALCULATION | | | |
|---|------------------|--------|--|
| LOCATION OF MAT CORES | | | |
| SUBLOT NO. | PAVEMENT STATION | OFFSET | |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| LOCATION OF JOINT CORES | | | |
| SUBLOT | PAVEMENT STATION | | |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| CALCULATED BY | | DATE | |
| AFFILIATION | | | |
| | | | |

