INTELLIGENT PAVING TECHNOLOGY

MILLING | PAVING | COMPACTION

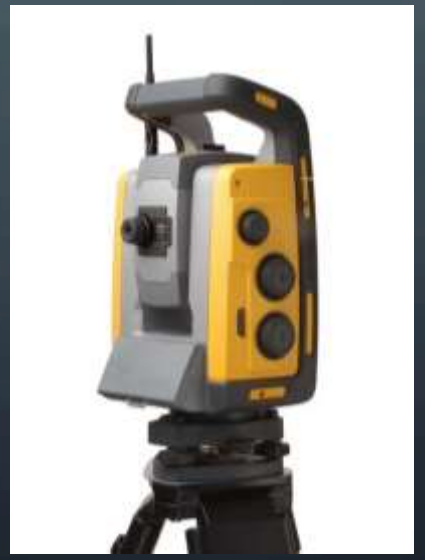
NELSON HAYS – ACCUPOINT INC

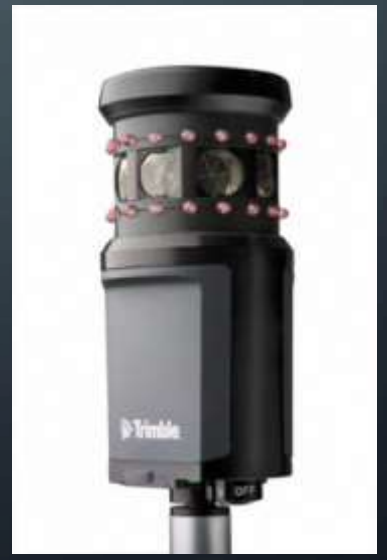
ACCUPOINT INC.

3D POSITIONING TECHNOLOGIES

UTS – Universal Total Station

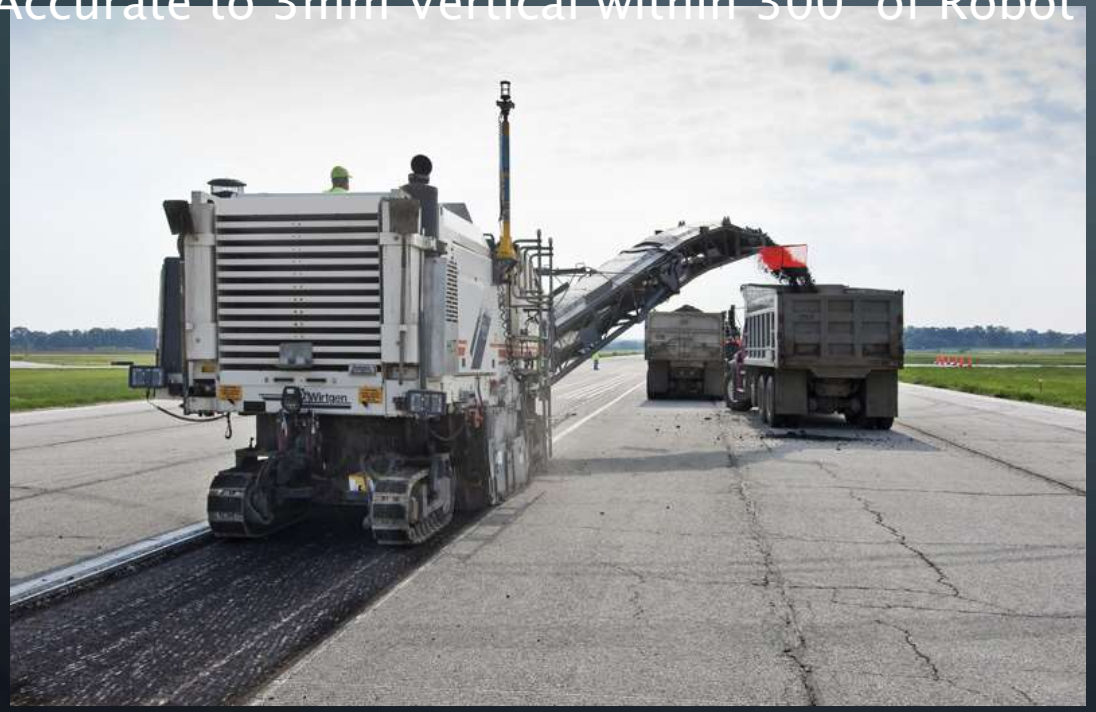
- 1” Optical Instruments
- Accurate to less than .026’ (.31”) at 1000’ from instrument





APPLICATIONS – UTS MILL

3D Mill to offset Subgrade
Irregular Pavement, re-alignments, engineered slopes
Accurate to 3mm Vertical within 300’ of Robot



APPLICATIONS – UTS MAINLINE PAVER

No more Stringlines, mitigate human-error
Accurate to 3mm Vertical within 300’ of Robot

APPLICATIONS – SURVEY

Quality Control Technician
Redundant Checks to confirm true accuracy
GNSS or UTS with same software

SMOOTH ASPHALT SURFACE BENEFITS

- Last Longer – less cracking, longer service life
- Improve Fuel Economy
- Decrease Mechanical failures
- Higher Quality Construction
- Cost Less – thinner overlays, longer service life
- Public Perception

LONGEVITY

"Smith used two different analytical techniques to investigate the effect of initial pavement smoothness on pavement life. The two analytical techniques that were used were: project specific regression models and analysis of failure curves. Project specific regression models were used for predicting pavement life to trigger roughness levels. The failure curve method was used to develop failure curves relating the percentage of failed projects (overlaid projects) as a function of time. Both analytical methods indicated that initial pavement smoothness has a significant effect on pavement life. It was shown that added pavement life could be obtained by achieving higher levels of initial smoothness. Combined results of both roughness model and pavement failure analyses indicated at least a 9 percent increase in life can be achieved by increasing the smoothness 25% from a target profile index values of … 5 to 3.5 in/mile for AC pavements. A 50 percent increase in smoothness from these target values was found to increase pavement life by at least 15 percent in many cases. Thus, an approximate increase in smoothness from … 5 to 2.5 in/mile based on profile index for AC pavements could conceivably yield at least a 15 percent increase in service life." (1)

↑50% Smoothness = ↑15% Service Life

LONGEVITY

1) Pavements with increased initial smoothness have *lower roughness levels* in the 10 years following construction.

2) Pavements with increased initial smoothness have *lower cracking levels* in the 10 years following construction.

3) Pavements with increased initial smoothness have *lower average annual maintenance costs* in the 10 years following construction. From a cost benefit standpoint, highway agencies can afford to expend considerable additional cost per lane mile (or kilometer) to build smoother roadways, being assured that these additional costs would be offset by a reduction in annual maintenance costs.

…Pavement smoothness is something the public not only understands but requires in highway construction. In a study conducted in 1996 by the National Quality Initiative (NQI) survey, highway users ranked concerns over Pavement Smoothness as most important (31%), followed by Safety (21%), Traffic Flow (19%), and Bridge Conditions (10%). This survey was further supported by a follow-up study in 2000, which came to the [same] conclusion.

These studies, as well as the American Association of State Highway and Transportation Officials (AASHTO) Road Test, confirm that all road users judge a road by its ride quality (smoothness). Clearly, roughness correlates directly to faults that exist in the road surface. These can vary from a bump to either longitudinal or transverse cracking or to the ultimate roughness, a “pothole."

Looking further into smooth roads and how initial smoothness in construction effects the life of the pavement, the National Center for Highway Research (NCHR) conducted their own studies under project 1-31. The results of the study clearly showed that smoothness also extended the life of a pavement. To increase a pavement's initial smoothness by 50%, (this is a minimal improvement by a single lift of HMA), the life of the road could be increased by as much as 27%.” (2)

CONSTRUCTION QUALITY

"The initial smoothness of a pavement is an indicator of the overall quality of construction of the pavement. If the pavement is constructed smooth, the contractor is likely to have provided good quality workmanship in other aspects of construction.

A survey of contractors indicated obtaining smoother pavements requires attention to other aspects of pavement construction thereby improving the overall quality of the pavement.

Therefore, a pavement that has a higher initial smoothness is expected to provide a longer service life than a pavement that has a lower initial smoothness, all other factors being equal." (1)

FUEL ECONOMY

"Researchers at the Westrack pavement testing facility near Reno, Nevada have found that smoother pavements cause improved fuel efficiency and reduce vehicle maintenance costs. At the Westrack facility, from 1997 to 1999, four driverless trucks traveled an average of 15- hours a day, around the 2.9 km oval track, simulating more than 10 years of interstate level traffic loads. Their runs were designed to evaluate how variations in hot-mix asphalt construction properties affect pavement performance and to validate the Superpave mix design and analysis procedures. During this time, some sections of the track developed varying amounts of roughness, rutting, and fatigue cracking, requiring major rehabilitation. The rehabilitation consisted of milling 4 inches from the AC surface and resurfacing.

To determine the effect of pavement quality changes on fuel economy, data from two identical Westrack vehicles were examined for periods just before and after March 1998 track rehabilitation. Prior to the rehabilitation, the track was in a rough condition with fatigue cracking of various test sections and deterioration of areas that had been patched after core sampling. The improvement resulting from the rehabilitation was evident in the International Roughness Index (IRI) values for the track, which showed that the average IRI had been reduced by at least 10 percent.

As part of the study of fuel economy, the fuel rate, fuel temperature, torque and engine speeds of the trucks were analyzed, as were fuel use data from daily inspections and refueling. The data showed that the average fuel mileage over an 8-week period before rehabilitation was 1.79 km/l. After rehabilitation, the average fuel mileage over a 7-week period was 1.86 km/l, indicating a 4.5 percent improvement. All other factors such as truck geometry, air temperature, and wind speed were either identical before and after rehabilitation or were compensated for within the comparison calculations. For a trucking company with a fleet operation of 1.6 million km, driving on smoother pavements would thus mean a saving of 46,660 l of fuel." (1)

Mill and Fill 4"

IRI improved <10%

-4.5% Avg Fuel Consumption

MECHANICAL FAILURES

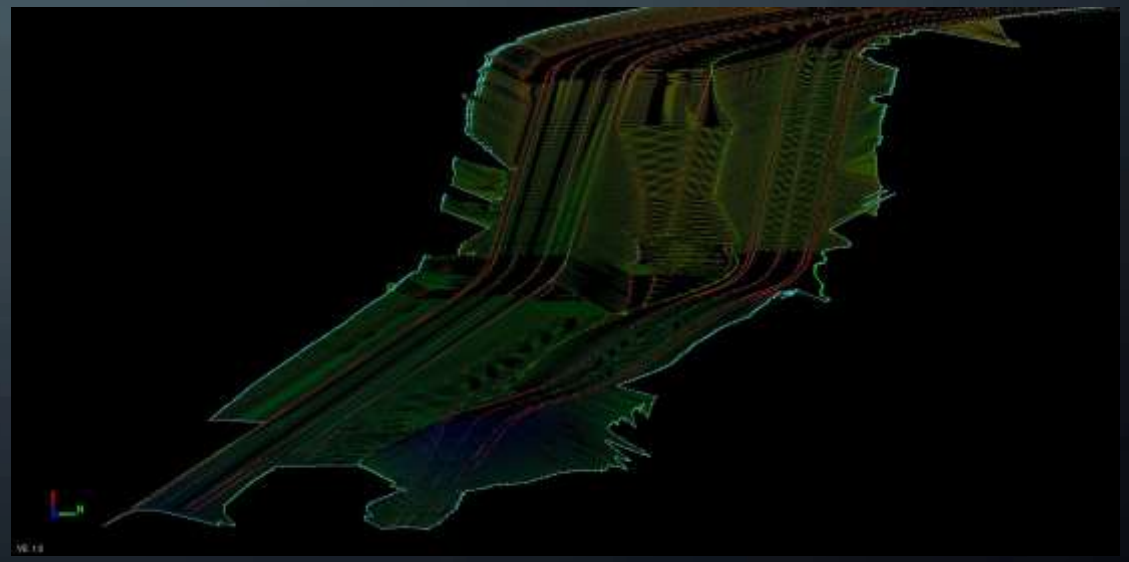
"The increased pavement roughness at Westrack also increased the frequency of failures in truck and trailer components. For example, during the weeks just before pavement rehabilitation, trailer frames began to fracture and required reinforcing welds, and steering motors and other components loosened more frequently. During the 2.5 years of traffic loading at the track, 8 of 17 trailer spring failures occurred within the 2 months prior to the March 1998 rehabilitation. Over these 2 months, 265,000 equivalent single axle loads (ESALs) were applied to the track. In contrast, the 350,000 ESALs applied in the 7 weeks after rehabilitation resulted in only one spring failure. … Substantial savings in vehicle maintenance cost for a smooth pavement could be inferred from the decrease in number of failures after rehabilitation." (1)

Before: 265,000 ESALs – 8 spring failures

After: 350,000 ESALs – 1 spring failure

ENGINEERED DESIGN

- New Finished Grade Surface
- Recent, Accurate Survey
- Match Curb/Utilities, or work around them
- Opportunity to Increase System Strength



CONSTRUCTION LOGISTICS

- Tight Vertical Accuracy
  - No Stringlines
  - No Leveling Course
  - Simpler Truck/Traffic Routing
- Paving Methods
  - Constant Speed – Paddle Wheels, Shuttle Buggies, etc.
  - Tandem Pavers – Hot Joints
  - Intelligent Compaction

REEF RUNWAY – CASE STUDY

– Honolulu International Airport (3)– 12,000’ long and 200’ wide, never resurfaced since ‘77

- “Because of the existing variable slopes of the runway, it would have been nearly impossible to mill everything to the new profile without using 3D technology. It saved us huge amounts of time and manpower in terms of layout, topos and establishing where the grades should be.”
- FAA and HDOT required $240,000 per day in damages for missing each 15-day segment deadline. Contractor met it with “superior smoothness” within the +/- ¼” tolerance
- One 6,000ft section was milled and paved to design in a 24-hour shutdown
- “…we were able to lay 5,000 tons of asphalt to grade and slope per night, in a 12-hour shift compared to 2,000 or 2,500 tons per shift, on other jobs.”
- “the total tonnage used to resurface the runway was 92,469 tons of asphalt,

ADOPTION

1. Spec It
   - Specific Tech, Best Practice Methods, Tight QC
2. Incentives/Penalties
   - Linear Bonus Scale – The smoother the better

SUMMARY

- Longer Service Life
- Improved Fuel Economy and Mechanical Reliability
- Simplified Construction Logistics
- Most Contractors are already invested in the CB460
- Better Quality Construction
- Faster Construction

SPECIAL SESSIONS

Intelligent Construction Technology Demonstration

November 18th

DOT Session: 10AM

100th and King St.

ACCUPOINT INC.
Construction Technology Solutions

Thank You

Nelson Hays

nelson@accupoint.com

907.570.6466

SOURCES

1. Issues in Pavement Smoothness: A Summary Report – NCHRP Project 20-51 – R. W. Perera, S. D. Kohn – Soil and Materials Engineers, Inc. Plymouth, Michigan – March 2002
2. Pavement Smoothness – J. Don Brock, Ph.D., P.E., Jim Hedderich
3. Tight Deadlines and Optimal Smoothness Achieved with Trimble 3D Milling and 3D Paving Technology – LINK