Stringless Paving

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Count on Concrete PAVEMENT

Stringless slipform paving technology

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Already being done at numerous airports around the country

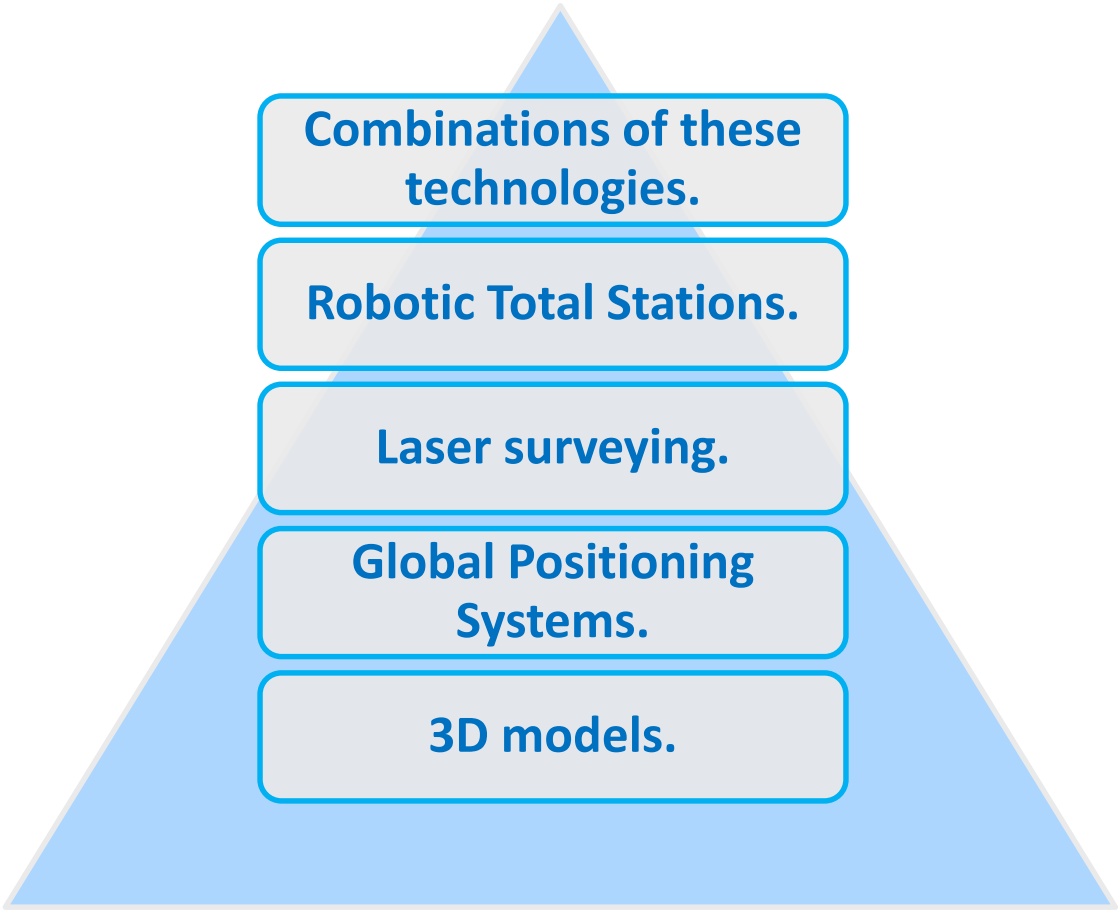
501-4.8 Placing concrete. -- a. Slip-form construction. The concrete shall be distributed uniformly into final position by a self-propelled slip-form paver without delay. The alignment and elevation of the paver shall be regulated from outside reference lines established for this purpose.

Introduction – What is Stringless Paving?

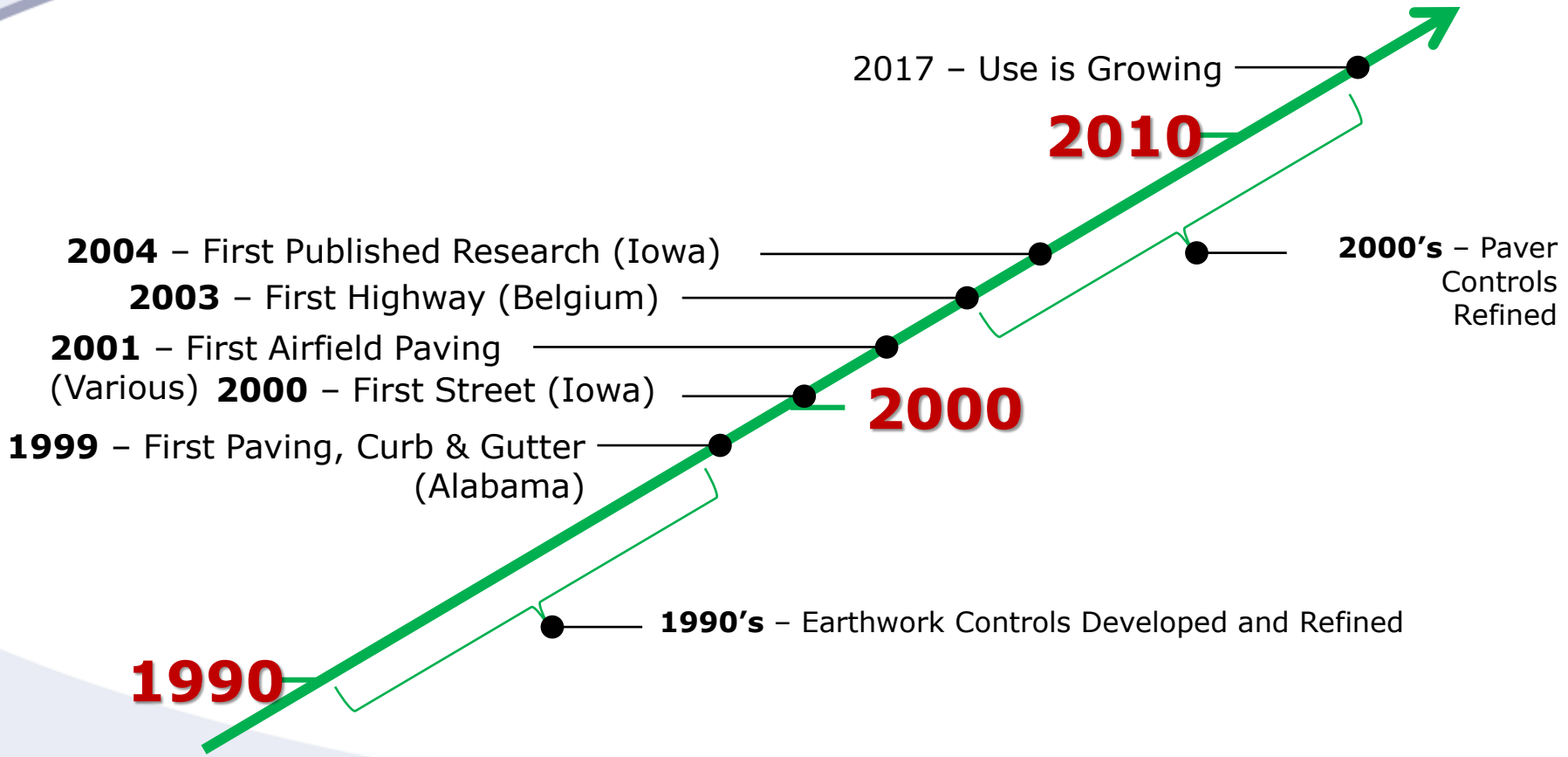
- Alternative to conventional stringline paving.
- Uses electronic guidance systems to replace pins, sensors, and “stringline.”
- Electronic guidance system controls elevation and steering of the paving machine(s).
- Sometimes referred to as 3D paving.

Is All Stringless Paving Technology the Same?

The concepts are similar, but there are options for the technology employed



Timeline of Development

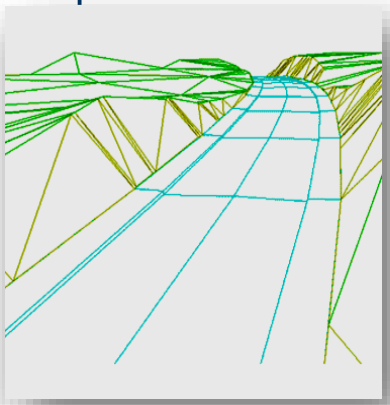


Introduction – The Four Basic Steps

- Step 1 – Create survey control network tied to known benchmarks.
- Step 2 – Collect field survey data of existing surface to build computer model.
- Step 3 – Design pavement/create 3D model; convert data for machine inputs.
- Step 4 – Transfer simplified model to the paving machine, set up 3D instruments, tie into controls; then pave.

STEP 1

STEP 2



STEP 3

STEP 4

ACPA Education & Training

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Similarities and Differences

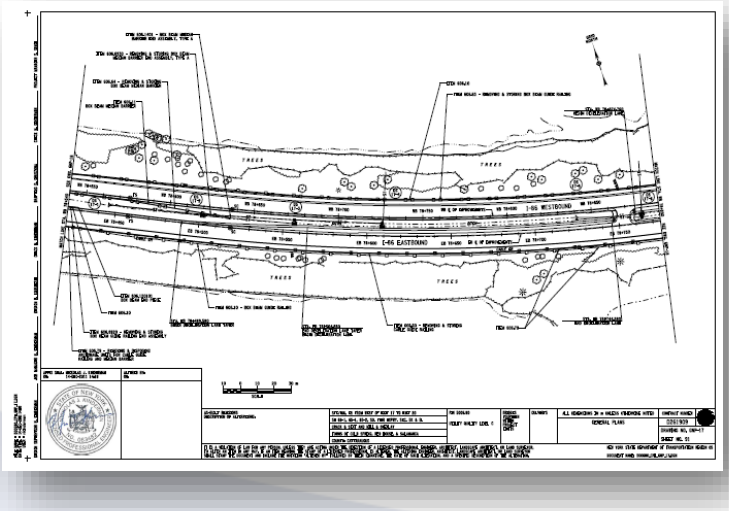
Accurate Surveying is Required!

- Both stringless and stringline paving methods require establishing a control network (or reference) for accurate paving.
- A string control method requires more labor intensive surveying to transfer the plan geometry to the grade.
- Stringless paving requires additional equipment, training and 3D data to build the pavement to plan.

⚠ **Both methods work and the accuracy of either starts with the survey controls!**

Basic Differences – Use of Technology

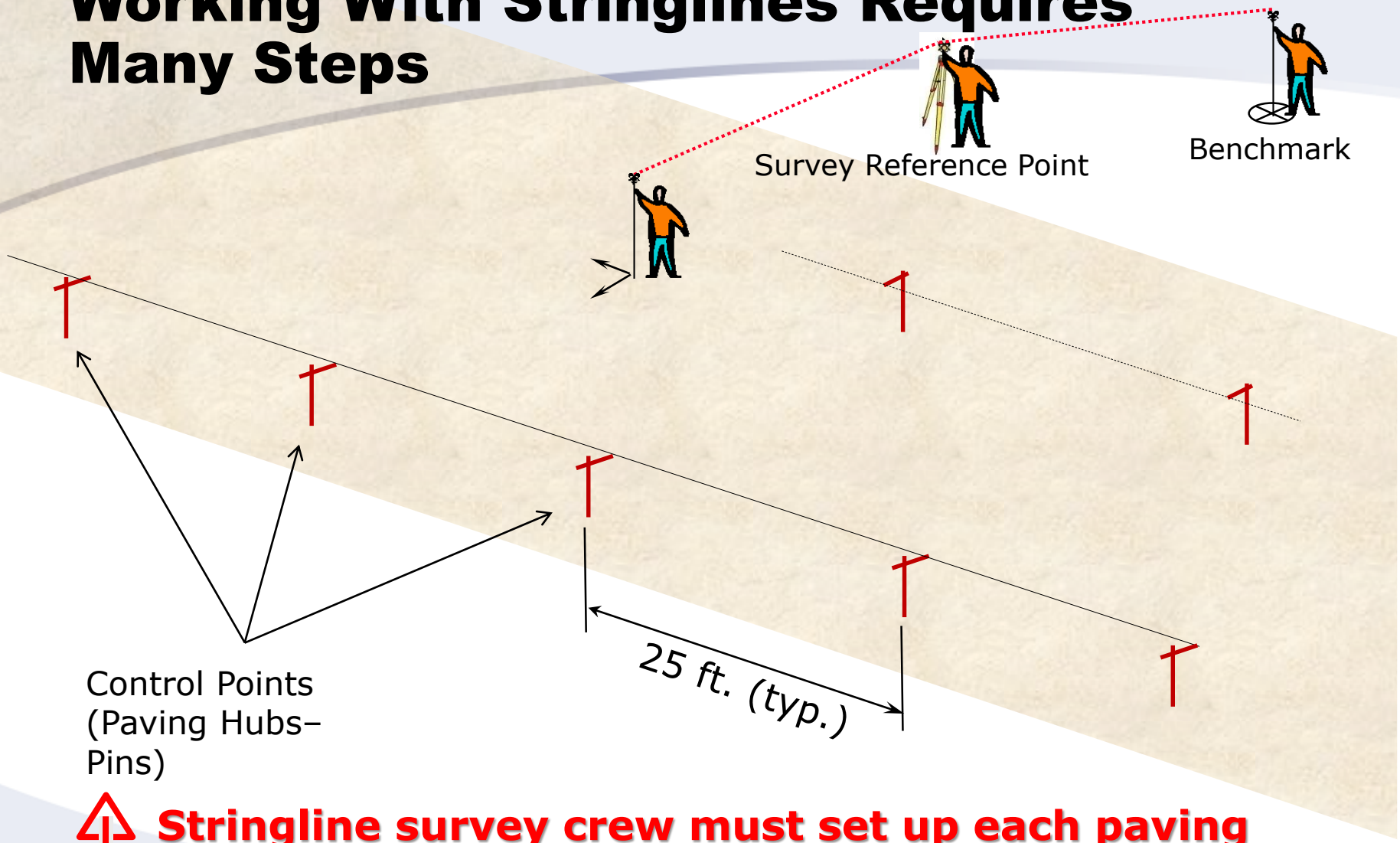
- How design data is used.
- The number of surveyed control points needed to control the paving machine.
- The opportunities for survey error.
- The trueness of the line and grade that the machine follows.



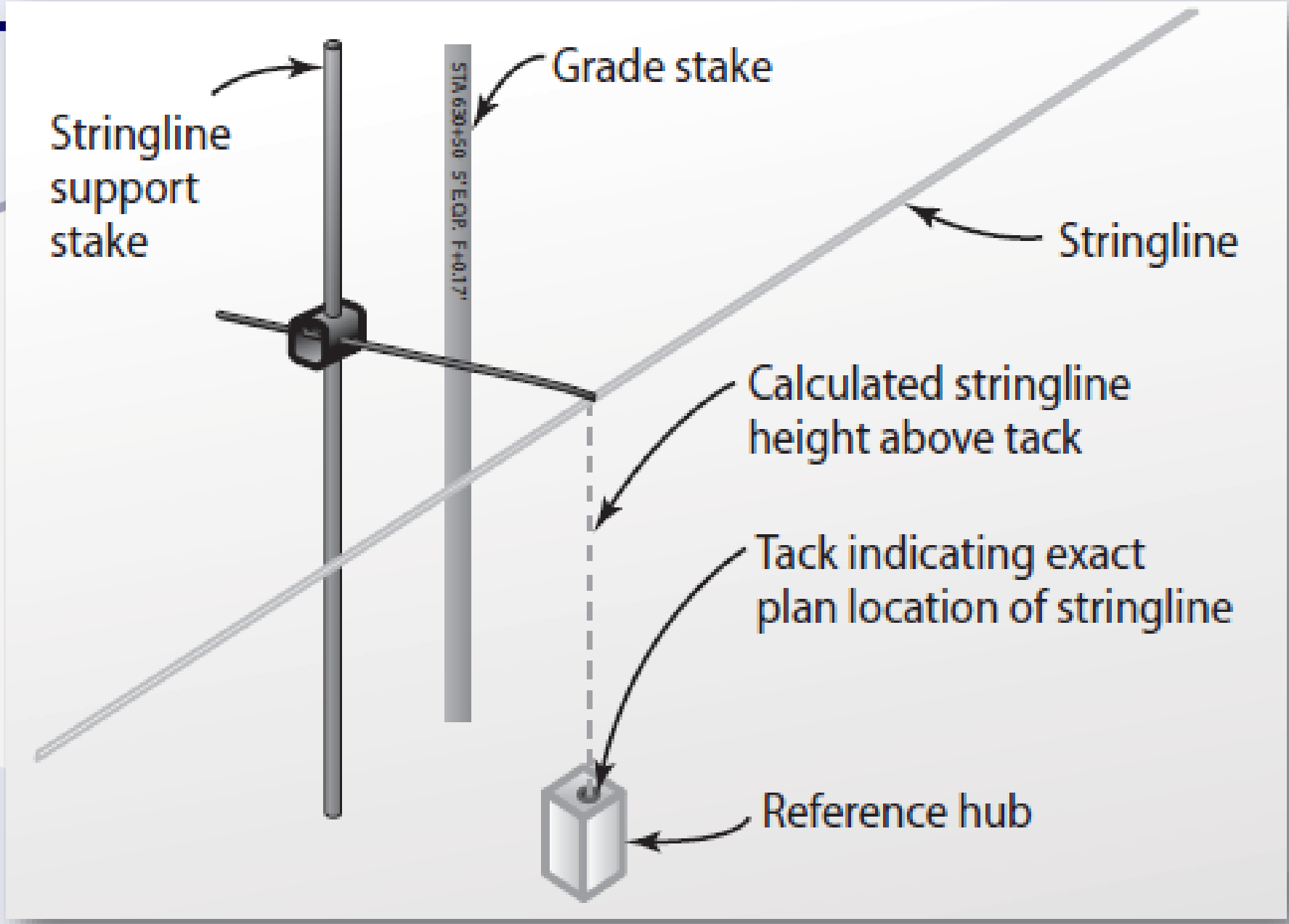
Engineering plan and profile is transferred to grade by a survey crew for stringline-controlled paving.

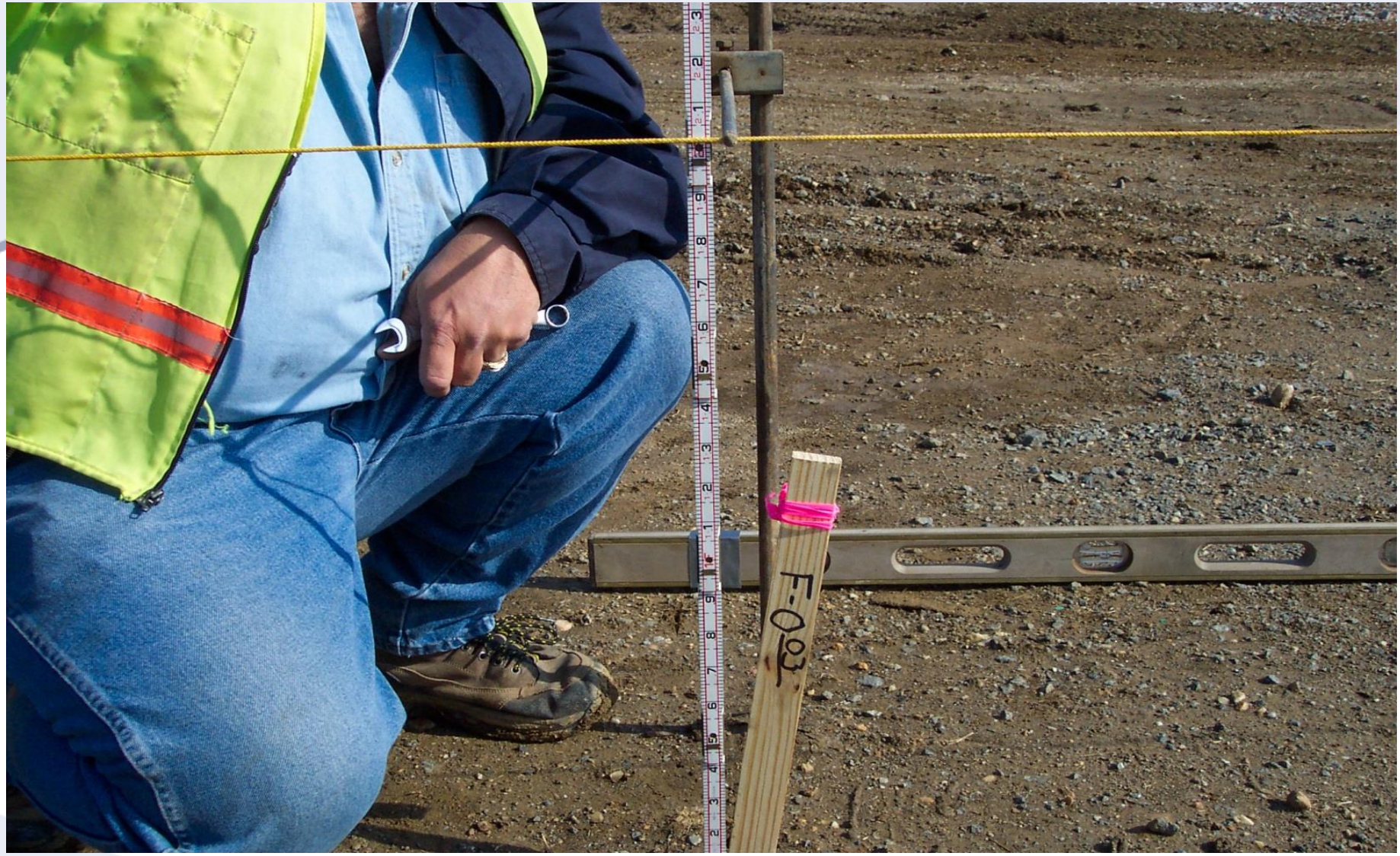
Engineering plan and profile is converted to 3-D model for stringless paving machine control.

Working With Stringlines Requires Many Steps



Stringline survey crew must set up each paving hub individually for stringline-controlled paving. There are many chances to introduce or compound errors.


Stringline support stake
Grade stake
STA 630+50 5' EQP. F+0.17'
Stringline
Calculated stringline height above tack
Tack indicating exact plan location of stringline
Reference hub



Stringline Surveying – Setting Grade on the Stake.

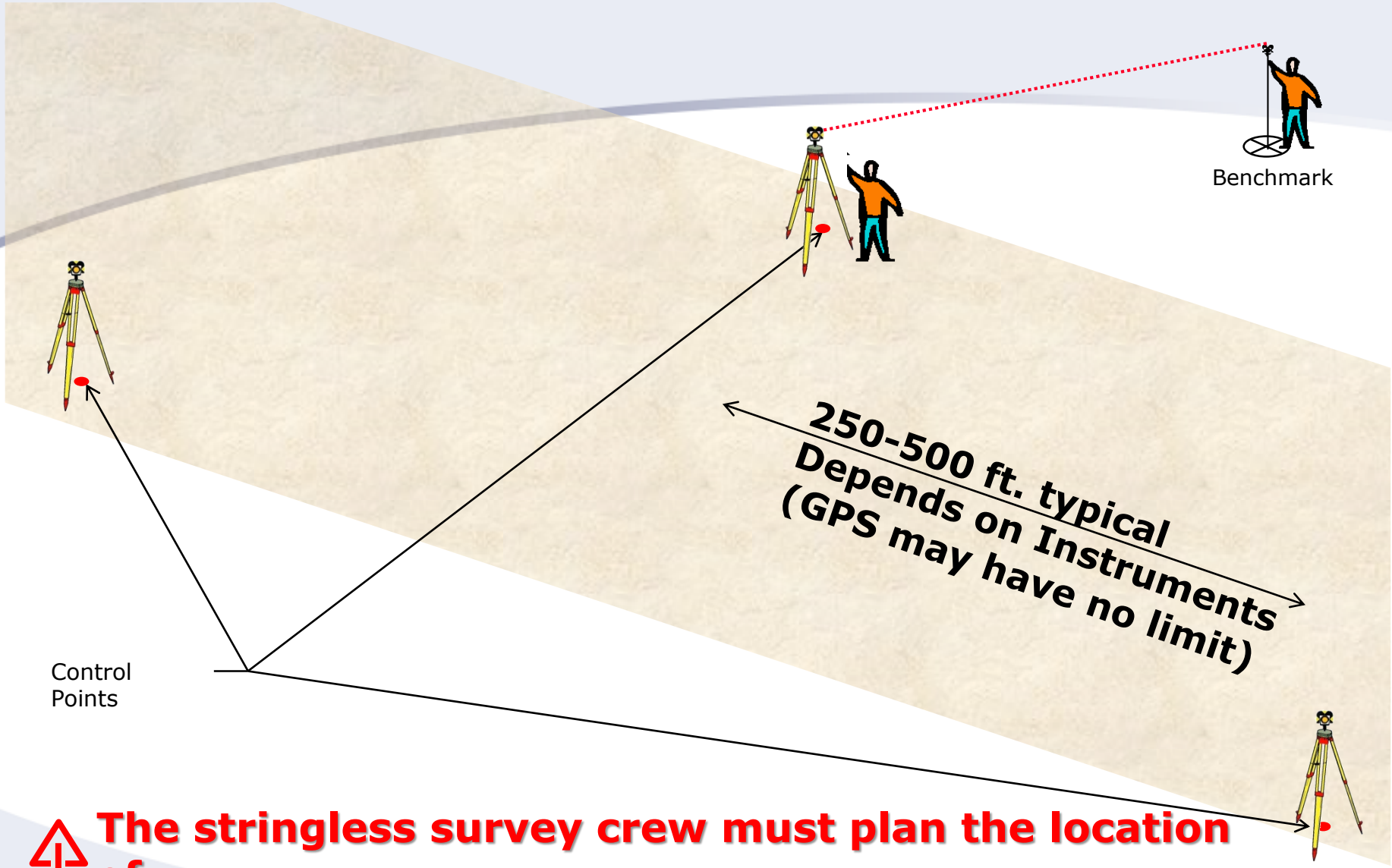
Field Surveying and Set-up Requirements for Stringless Paving

Establish Control Network:

- Control points established from field surveying.
- 2 person crew.
- Control points tied to known benchmark(s).
- Should be positioned:
  - Out of way of any operations.
  - Where they will not be bothered by the public.
  - To allow instruments for machine control to see at least three control points at all times.

The Typical Steps Working With Stringless Paving

1. Surveying control point locations in the field at about 250 ft intervals for total station control and even greater intervals for laser or GPS control.
2. Placing each control point.
3. Performing automated surveying of the project site to build the terrain model.
4. Developing 3D model from plans.
5. Error-checking the 3D model.
6. Setting up instruments on the grade and tying them into at least three control points for paving.
9. Moving machine into position & checking (validating) the pan elevation using the instruments before paving.
10. Checking radio and/or laser communication between instruments and paver.
11. Moving the instruments along the grade as paving progresses.



⚠ **The stringless survey crew must plan the location of control points. The number depends on terrain, urban development and instruments (total station, laser or GPS)**

Time Efficiency Improvements with Stringless

- Reduces field surveying.
- Eliminates labor intensive stringline surveying for hubs and stakes.
- Eliminates need for string line, stakes and accessories.
- Reduces opportunities to introduce surveying errors.
- Reduces overall preparation time on the grade.

⚠These efficiencies will save construction costs while the technology will improve paving quality!

Spatial Requirements Reduced with Stringless

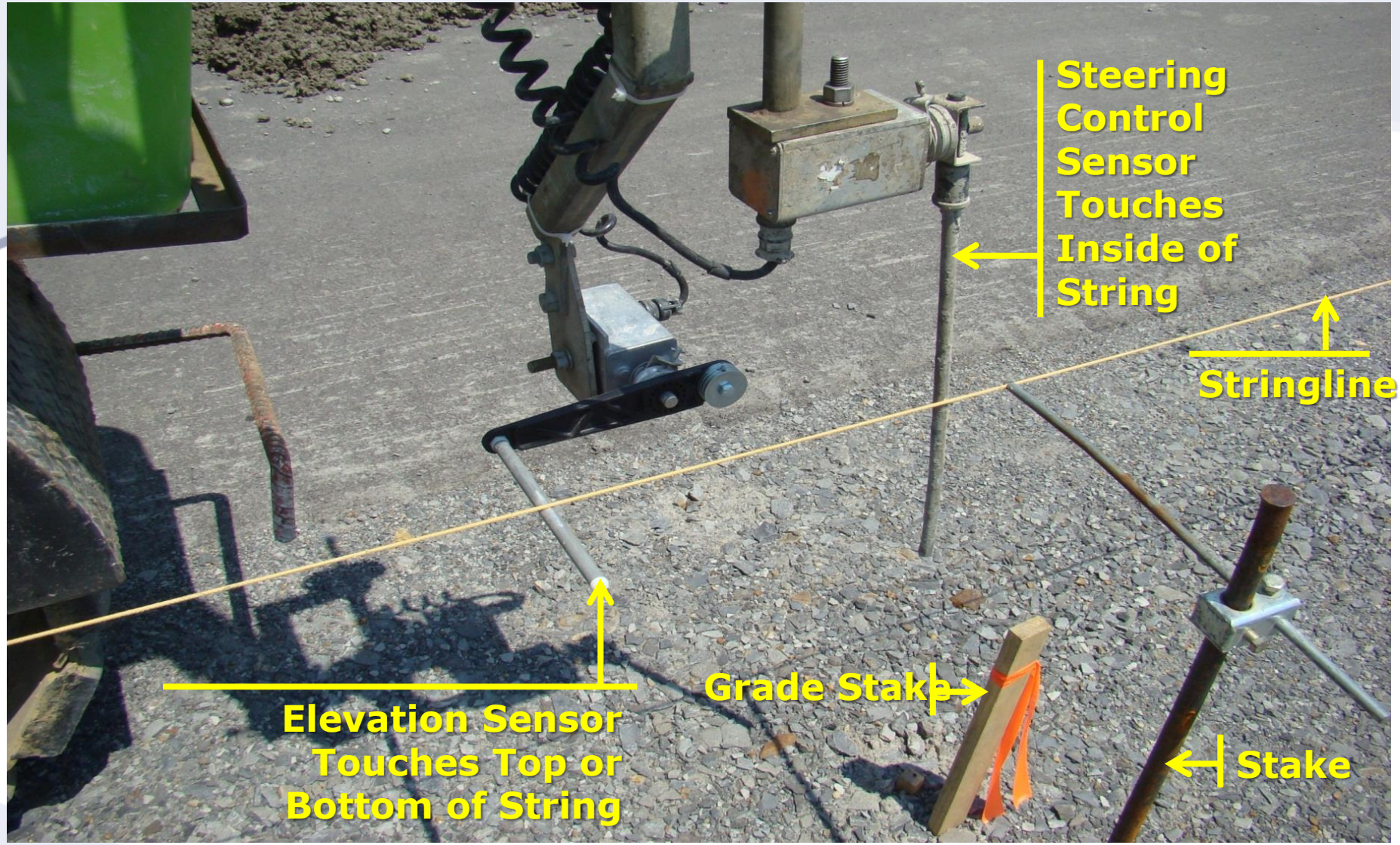
- A string-controlled operation requires about 5 feet clearance on each side:
  - 3 ft. for paver track and workers.
  - 1 ft. for hubs and stringline stakes.
  - 1 ft. for safety devices
- A stringless operation requires 1-2 feet less clearance on each side.
- Benefits:
  - Increases phasing and traffic control pattern considerations.
  - Improves project feasibility.
  - Provides safer access to grade for crew and trucks.

Stringless technology helps increase feasibility of concrete paving in tight areas.

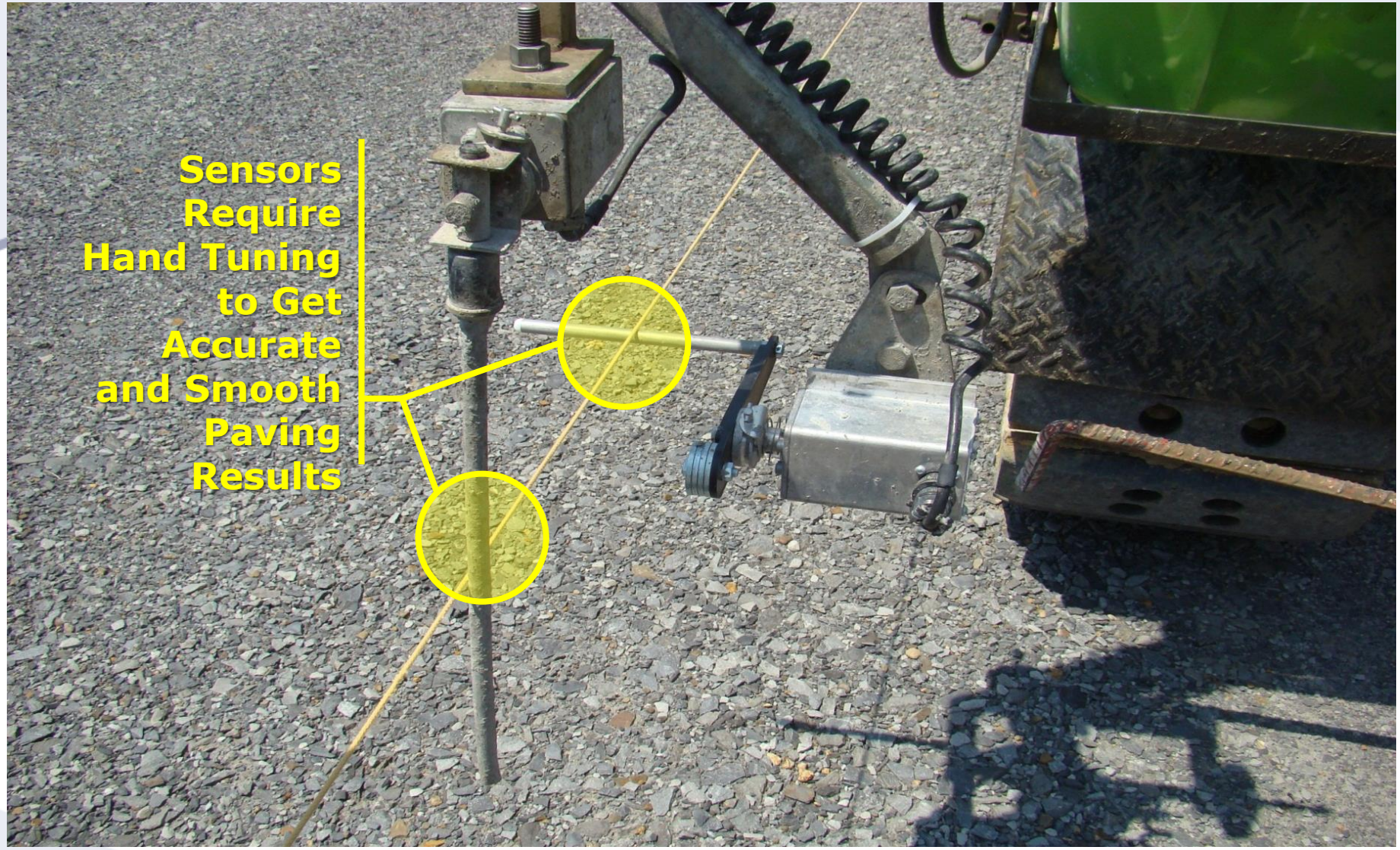
Machine Control Improvements with Stringless

- Places engineer's design directly into machine(s).
- Controls elevation, slope, and steer of machines with truer input.
- Reduces or eliminates cords created by stringline hubs/pins.
- Reduces wave patterns introduced by improperly tensioned stringline sensors.

The control points that link the 3D model to the real world are the key to paving accuracy.



Sensors for Controlling Machine Elevation and Position.



Sensors for Controlling Machine Elevation and Position.

Stringlines represent the pavement using a series of cords.

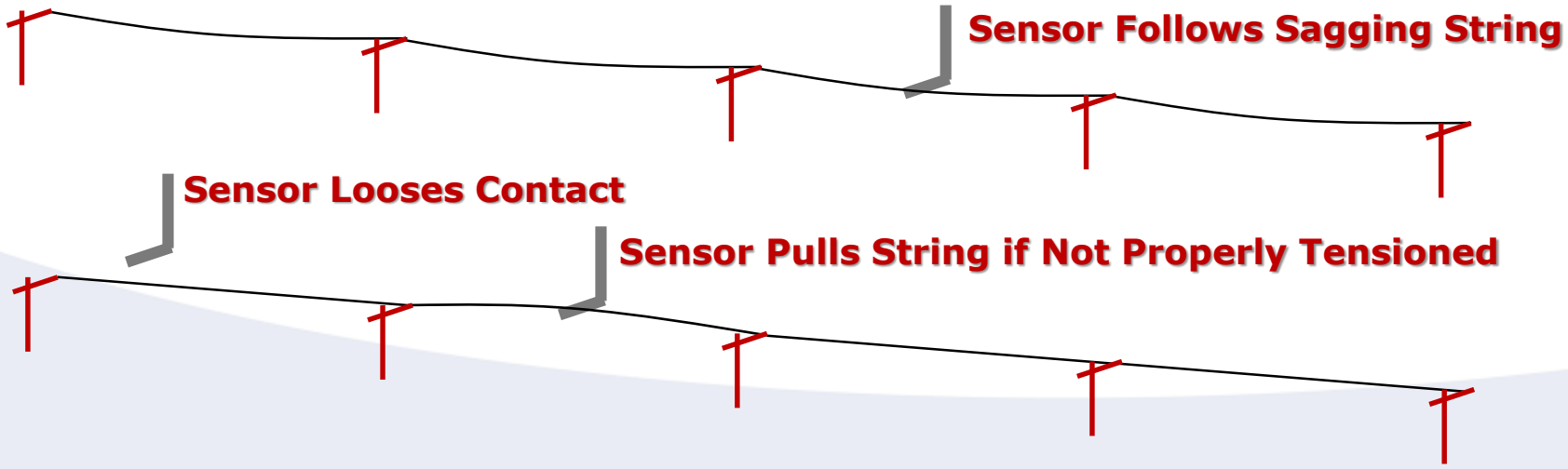
The cords are easy to see in this curve – even with a close staking interval.

These cords are built into the pavement, as can be seen here with cords in a horizontal curve.

Stringless technology represents the pavement using mathematical equations representing tangents and curves (a “true” profile).

Smoothness Benefits with Stringless

- Eliminates cords in vertical curves.
- Eliminates stringline factors affecting smoothness:
  - Sag (stringline expansion in hot weather).
  - Push up (improperly tensioned sensors).
  - Deviations from loss of contact.
  - Bumps from knots/splices.
  - Crew fidgeting with sensor controls.



Quality and Process Control Benefits with Stringless

- More precise machine control (digital) to much smaller increments.
- Better and more consistent ride quality.
- Control over material quantities and costs.
- Lower yield loss.

Control of horizontal and vertical curves is significantly more accurate to the plan – arcs are paved versus a series of cords!

Stringless control of thick airport paving.

What's Required to Transition to Stringless?

Contractor:

- Capital expenditures.
- Investment in instruments for control (control points).
- Understanding line-of-sight for instruments.
- Understanding weather and environmental considerations for total stations, lasers and GPS.
- Learning curve/training – dedication of trained personnel to run stringless operation and work with 3D model.

What's Required to Transition to Stringless?

- Owner/Agency:
  - Acceptance – allow its use.
  - Adopt end-result mindset (specifications) for thickness, smoothness.
  - Provide (or validate) control points.
  - Provide plans and CAD files to contractor for use in creating 3D model.
  - Learning curve/training for field inspection or construction management staff.

Questions or Comments