

Construction Staking Subgrade, Item 650.4500

Conform to standard spec 650 as modified in this special provision.

Replace standard spec 650.3.3 with the following:

650.3.3 Subgrade

650.3.3.1 General

- (1) Under the Construction Staking Subgrade bid item the contractor may substitute global positioning system (GPS) machine guidance for conventional subgrade staking on all or part of the work. The engineer may require the contractor to revert to conventional subgrade staking methods for all or part of the work at any point during construction if, in the engineer's opinion, the GPS machine guidance is producing unacceptable results.

650.3.3.2 Subgrade Staking

- (1) Set construction stakes or marks at intervals of 100 feet, or more frequently, for rural sections and at intervals of 50 feet, or more frequently, for urban sections. Include additional stakes at each cross-section as necessary to match the plan cross-section, achieve the required accuracy, and to support construction operations. Also set and maintain stakes as necessary to establish the horizontal and vertical positions of intersecting road radii, auxiliary lanes, horizontal and vertical curves, and curve transitions. Locate stakes to within 0.25 feet (75 mm) horizontally and establish the grade elevation to within 0.03 feet (10 mm) vertically.

650.3.3.3 GPS Machine Guidance

650.3.3.3.1 General

- (1) No subgrade stakes are required for work completed using GPS machine guidance.
- (2) Coordinate with the engineer throughout the course of construction to ensure that work performed using GPS machine guidance conforms to the contract tolerances and that the methods employed conform to the contractor's GPS work plan and accepted industry standards. Address GPS machine guidance issues at weekly progress meetings.

650.3.3.3.2 GPS Work Plan

- (1) Submit a comprehensive written GPS work plan for department review at least 5 business days before the preconstruction conference. The engineer will review the plan to determine if it conforms to the requirements of this special provision.
- (2) Construct the subgrade as the contractor's GPS work plan provides. Update the plan as necessary during construction of the subgrade.
- (3) The GPS work plan should discuss how GPS machine guidance technology will be integrated into other technologies employed on the project. Include, but do not limit the contents to, the following:
 1. Designate which portions of the contract will be done using GPS machine guidance and which portions will be done using conventional subgrade staking.

2. Describe the manufacturer, model, and software version of the GPS equipment.
3. Provide information on the qualifications of contractor staff. Include formal training and field experience. Designate a single staff person as the primary contact for GPS technology issues.
4. Describe how project control is to be established. Include a list and map showing control points enveloping the site.
5. Describe site calibration procedures. Include a map of the control points used for site calibration and control points used to check the site calibration. Describe the site calibration and checking frequency as well as how the site calibration and checking information are to be documented.
6. Describe the contractor's quality control procedures. Describe procedures for checking, mechanical calibration, and maintenance of equipment. Include the frequency and type of checks performed to ensure that the constructed subgrade conforms to the contract plans.

650.3.3.3.3 Equipment

- (1) Use GPS machine guidance equipment to meet the requirements of the contract.
- (2) Perform periodic sensor calibrations, checks for blade wear, and other routine adjustments as required to ensure that the final subgrade conforms to the contract plans.

650.3.3.3.4 Geometric and Surface Information

650.3.3.3.4.1 Department Responsibilities

- (1) At anytime after the contract is awarded the contractor may request the contractor staking packet. The department will provide the packet within 5 business days of receiving the contractor's request.

650.3.3.3.4.2 Contractor Responsibilities

- (1) Develop and maintain the initial design surface DTM for areas of the project employing GPS machine guidance. Confirm that the design surface DTM agrees with the contract plans.
- (2) Provide design surface DTM information to the department in LandXML or other engineer-approved format.

650.3.3.3.4.3 Managing and Updating Information

- (1) Notify the department of any errors or discrepancies in department-provided information. The department will determine what revisions may be required. The department will revise the contract plans, if necessary, to address errors or discrepancies that the contractor identifies. The department will provide the best available information related to those contract plan revisions.
- (2) Revise the design surface DTM as required to support construction operations and to reflect any contract plan revisions the department makes. Perform checks to confirm that the revised design surface DTM agrees with the contract plan revisions. Provide a copy of the resultant revised design surface DTM to the engineer in LandXML or other

engineer-approved format. The department will pay for costs incurred to incorporate contract plan revisions as extra work.

650.3.3.3.5 Site Calibration

- (1) Designate a set of control points, including a total of at least 6 horizontal and vertical points or 2 per mile, whichever is greater, for site calibration for the portion of the project employing GPS machine guidance. Incorporate the department-provided control framework used for the original survey and design.
- (2) Calibrate the site by determining the parameters governing the transformation of GPS information into the project coordinate system. Use the full set of control points designated under 650.3.3.3.5 (1) for the initial site calibration. Provide the resulting site calibration file to the engineer before beginning subgrade construction operations.

650.3.3.3.6 Construction Checks

650.3.3.3.6.1 Daily Calibration Checks

- (1) In addition to the site calibration, perform site calibration checks. Perform these checks at individual control points not used in the initial site calibration. At a minimum, check the calibration at the start of each day as described in the contractor's GPS work plan. Report out-of-tolerance checks to the engineer. The measured position must match the established position at each individual control point within the following tolerances:
 - Horizontally to 0.10 feet or less.
 - Vertically to 0.05 feet or less.
- (2) Discuss the previous week's daily calibration check results at the weekly progress meeting for monitoring the GPS work.

650.3.3.3.6.2 Final Subgrade Elevation Checks

- (1) Check the subgrade against the plan elevation at randomly selected points on cross sections located at stations evenly divisible by 100. Conduct at least 20 random checks per stage, per project, or per roadway mile whichever results in the most tests. Also check the subgrade at additional points as the engineer directs. Notify the engineer at least 2 business days before making subgrade checks so the engineer can observe the process.
- (2) Ensure that at least 4 of any 5 consecutively tested random subgrade points are within 0.10 foot vertically of the plan elevation. Notify the engineer if more than one of any five consecutively tested random subgrade points differs by more than 0.10 feet from the plan elevation.
- (3) The department may conduct periodic independent subgrade checks. The department will notify the contractor if any individual check differs by more than 0.10 feet from the design.