OREGON DEPARTMENT OF TRANSPORTATION

Geometronics

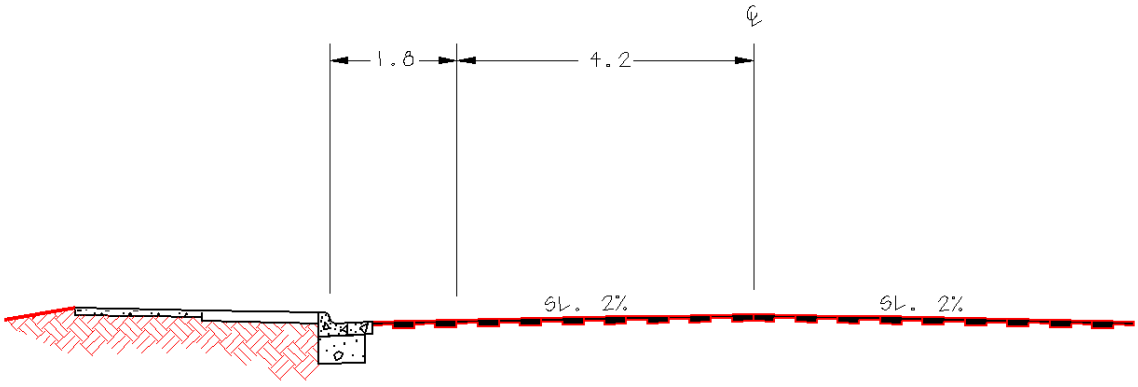
200 Hawthorne Avenue
Suite B250
Salem, OR 97310
(503) 986-3103

Ron Singh, PLS
Chief of Surveys
(503) 986-3033

David Artman, PLS
Lead Photogrammetrist
(503) 986-3017

Dave Brinton, PLS, WRE
Interim Lead Surveyor
(503) 986-3035

Lorne Brown, LSIT
Survey Support Specialist
(503) 986-3034



Cross Slope Verification Surveys

February, 2002

Introduction

This document describes why designers have been requesting complete Digital Terrain Models (DTM) for Preservation projects, and provides an alternate low cost solution to accommodate that need.

The Requirement for Cross Slope Verification

ODOT Preservation projects need to comply with modified 3R standards. The standards for superelevation and tangent cross slopes for these types of projects are dependent on the type of highway; whether the highway is a Non-Freeway (category 1-5) or a Freeway.

The ODOT Highway Design Manual requires that for 3R Preservation projects the superelevation and tangent cross slopes meet ODOT's standards for new construction. If these cross slopes do not meet the standards, they must be corrected as part of the design and construction, or a Design Exception justified and approved. Design Exceptions must be approved by the FHWA. The Design Manual prohibits granting blanket exceptions on any class of project.

To comply with the requirements mentioned above, designers need to know the existing tangent cross slope and superelevation values. During the past year or so, many designers have requested that survey crews develop a full DTM of the project area on Preservation projects. However, this procedure is not consistent across the State as many offices simply use Straight Line Charts to develop the design for these projects.

Based upon current procedures for the development of As-Constructed diagrams and poor record keeping for changes made to the roadway by maintenance activities, the determination of existing cross slopes must be made by field measurements. This does not preclude the use of other technology to gather the data. In the future, if ODOT embarks on developing a database of coordinate correct As-Constructed data, this step may be eliminated.

Pre-Survey Considerations

The Project Leader should hold a Project Decision Team (PDT) meeting before any survey work is performed. The scope of the project should be determined at this meeting and a determination made as to the level of effort needed for the field survey work.

For Pave-Only projects, very little surveying is necessary. However, most Preservation projects have many other design considerations involved that create the need for a higher level of survey work. As the project is developed, many of these don't even survive as a Preservation project. While scoping, rural Preservation projects should be looked at closely for guardrail and cross slope issues, while urban Preservation projects should be looked at critically for curb exposure; Americans with Disabilities Act (ADA) requirements; sidewalks and ramps; driveway slopes; traffic signals; and superelevation and cross slope issues. Any of these could push the project costs beyond that for just a Preservation project.

To develop a "full blown" DTM is an expensive and time-consuming task. Using ground survey methods in urban areas could cost several thousand dollars per kilometer, and by using low-level helicopter Photogrammetry; the costs could be even higher.

Many sections of Oregon's highways are extremely difficult to survey. Heavy volumes and high-speed traffic make surveyor-occupied measurements within the travel lanes near impossible. Even working close to the traffic can be very unsafe. On many sections lane closures are restricted to between 11 pm and 5 am.

It is important that surveyors have a good understanding of the needs of all the parties that rely on their survey data. Many surveyors are insisting on only working on a project once and consider a return trip to the site (to add to the survey) to be inefficient. Knowing that the surveyors may not return to the project for quite some time to collect more data, many designers are requesting more than what is necessary to ensure they have all the data they need. In reality, very often it is more appropriate to visit the site to collect a minimum amount of data that would help the designer make a better decision on the extent of the survey, and then return to the site to conduct a more tailored survey based upon the designers evaluation of the information. Cross Slope Verification surveys are a good example of this.

If a detailed DTM covering the entire project is needed for design work, a survey obviously needs to be conducted. However, if the designer is simply trying to gain knowledge of the existing superelevation and tangent cross slope conditions to further decide how to proceed, it is far better to collect the minimum amount of data to achieve that. It would be a tremendous waste of funds to develop a full DTM to simply utilize it to extract cross slope information to justify a Design Exception.

If the Cross Slope Verification survey determined that the highway did not meet standards and the decision was made to bring it up to standards, a subsequent more detailed survey should be conducted. This may include a full DTM. However, if the decision were made to simply request a Design Exception, no further survey would be necessary.

The Cross Slope Verification Survey

A Cross Slope Verification survey is not intended to provide data for design. The intent of this type of survey is to collect the minimum amount of data needed to reasonably depict the cross slopes and superelevation within the project limits so that the design team can either request a Design Exception or elevate the project scope to fix the deficiency. The latter option would require a detailed survey.

In discussions with the Roadway Section Management Team we have concluded that a sampling of the slopes once every kilometer in tangent sections and three per curve segment is sufficient. For the curve segment, one is needed on each side of the curve within each super runoff zone, and one mid curve at full super.

A sampling could consist of a developing a Cross Section or a pocket DTM of the roadway surface.

Cross Sections

If the Cross Section method is utilized, the measurements must be taken using a level or Total Station. The Cross Section must be maintained perpendicular to the alignment and elevation accuracies within 1cm. This method would also require identifying the location of the Cross Section by stationing; milepost; or coordinates. Enough ties to centerline evidence must be made to approximately relate the Cross Section to the alignment stationing. This is only important for the Cross Sections in curves, so that the computed cross slope can be compared to the required superelevation for that particular station.

It is preferable, but not necessary to relate each Cross Section to each other by a common elevation datum. Each Cross Section could be based on an assumed elevation at it's centerline position.

Pocket DTMs

This method essentially develops a mini DTM of the roadway surface at each sampling location. A Total Station must be used. Elevation accuracies must be maintained within 1 cm. The location of each Pocket DTM will be identified by it's coordinates. Enough ties to centerline evidence must be made to approximately relate the DTM to the alignment stationing. This is only important for the DTM in curves, so that the computed cross slope can be compared to the required superelevation for that particular station.

The intent is to develop a Pocket DTM for the width of the roadway approximately 100m long. This can generally be achieved with one setup with the reflectorless instrument. If a median barrier restricts visibility to the opposite side of the roadway, a setup on each side may be necessary. If conditions (such as heavy rain) will not allow measurements to develop the 100m long DTM, a shorter length is permissible.

The advantage of a Pocket DTM is in the collection procedure. The surveyor does not have to determine the stationing or maintain a Cross Section perpendicular to the alignment. A reflectorless instrument (as described below) can be utilized very effectively for this survey. The designer would utilize the Pocket DTM to cut Cross Sections for analysis.

Reflectorless Instrumentation

Geometronics owns two TCRA1101 Total Stations that were acquired specifically for reflectorless use. These instruments are best suited for reflectorless (no rod-person) measurements for features such as rock faces that have a relatively large angle of incidence (to provide the strongest EDM return signal) and that present a challenge to surveyors to walk on. However, these instruments have been tested by Geometronics for use on very shallow angle of incidence features, such as roadway surfaces, and found to work well and maintain accuracy up to a distance of 60m from the instrument. These instruments are ideal for the development of Pocket DTMs of roadway surfaces where a rod-person cannot safely go. This is not a good instrument to use to measure Cross Sections because of the difficulty in maintaining the Cross Section perpendicular to the alignment.