

# How Design Survey, Design, Stakeout and AMG Interact

Measuring Technologies

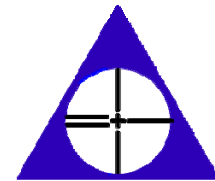
Establish Control

Create a Model

Machine Control

AMG and Stakeout

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# Measuring Technologies

- GPS
- Post Processed Static GPS – exceptional horizontal – vertical 0.03-0.05+/-
  - spend not less than 10 minutes and sometimes hours on a point depending on the length of the baseline
  - Requires processing in the office
- Post Processed Kinematic, fast static, rapid static – very good horizontal – so so vertical
  - Still going to be stationary 3 to 5 minutes
- I don't do much Post Processed Kinematic – the point is that the data still needs to go to the office to be usable
- Real Time Kinematic – generally good to 0.1'+/- not recommended for control unless you think 0.1' is OK
- Weakest part of GPS is the vertical

# Measuring Technologies

- TOTAL STATION OR ROBOTIC TOTAL STATION
- Pluses
- Minuses

# Measuring Technologies

- Error Budget – all the factors that contribute to error
  - Rod
  - Tribrach
  - Measure ups
- SUB TOTAL =  $0.012 + 0.005 = 0.017'$  +/- Horizontal and  $0.005'$  +/- Vertical
- RTK Horizontal Precision
- RTK Vertical Precision

# Measuring Technologies

- Robotic Total Station Precision
- Example of real field data for sample of precision:

○	Backsight: Name: 3	SD: 337.601	ZE: 090-03'05	VD: 0.301	HD: 337.601	HI: 4.726	Desc: CR
○	Backsight: Name: 3	SD: 337.600	ZE: 269-56'53	VD: -0.302	HD: 337.600	HI: 4.727	Desc: CR
○	Backsight: Name: 3	SD: 337.601	ZE: 090-03'06	VD: 0.303	HD: 337.601	HI: 4.728	Desc: CR
○	Backsight: Name: 3	SD: 337.600	ZE: 269-56'53	VD: -0.303	HD: 337.600	HI: 4.728	Desc: CR
○	Backsight: Name: 3	SD: 337.601	ZE: 090-03'05	VD: 0.301	HD: 337.601	HI: 4.726	Desc: CR
○	Backsight: Name: 3	SD: 337.600	ZE: 269-56'55	VD: -0.299	HD: 337.600	HI: 4.724	Desc: CR

- Complacency
- [http://www.surveying.com/tech\\_tips/index.asp](http://www.surveying.com/tech_tips/index.asp)
- This is a website address for equipment adjustments

# Establish Control

- The 4 elements of control:
  - Design Control Survey
  - Preliminary Design or Design Location Survey
  - Construction Control Survey
  - AMG or Traditional Stakeout
- The most critical element is the 1<sup>st</sup> because everything builds on it.
- When the Design Control Survey is performed it is not limited to creating a point in the ground, the Design Control Survey also has a relationship between the points that is unique unto itself and is usually defined by the stated precision of the survey
  - All location should be from the Design Control
  - All Construction Control should be established from the Design Control
  - The actual tie downs to hard surfaces should be located from the Construction Control for the model – all of which is established from the Design Control
  - All AMG or Stakeout should be from the Construction Control that was established from the Design Control

# Establish Control

- Old way concentrating on just traditional technology
  - Set Design Control by traverse and/or Static GPS close to roadway, generally in the right of way.
  - Have the control destroyed by construction.
  - Re-establish control to replace the control that was destroyed.
- New way using RTK and other Field Technology.
  - Set as much of the design control outside of construction as possible.
  - Perform Total Station Resection (free station) as needed for working position.

# Total Station Resection

- Reading 1(D):FP1,AR0.0000,ZE89.2213,SD99.6690--IRS,HR4.970
- Reading 1(R):FP1,AR180.0000,ZE270.3752,SD99.6673--IRS,HR4.970
- Reading 2(D):FP1,AR0.0001,ZE89.2212,SD99.6693--IRS,HR4.970
- Reading 2(R):FP1,AR180.0001,ZE270.3754,SD99.6680--IRS,HR4.970
- Reading 3(D):FP3,AR37.0100,ZE90.0309,SD337.5991--IRS,HR4.970
- Reading 3(R):FP3,AR217.0100,ZE269.5658,SD337.5988--IRS,HR4.970
- Reading 4(D):FP3,AR37.0103,ZE90.0309,SD337.5991--IRS,HR4.970
- Reading 4(R):FP3,AR217.0100,ZE269.5658,SD337.5984--IRS,HR4.970
- Reading 5(D):FP4,AR52.0929,ZE90.2643,SD296.4376--IRS,HR4.970
- Reading 5(R):FP4,AR232.0927,ZE269.3324,SD296.4363--IRS,HR4.970
- Reading 6(D):FP4,AR52.0927,ZE90.2646,SD296.4373--IRS,HR4.970
- Reading 6(R):FP4,AR232.0927,ZE269.3325,SD296.4366--IRS,HR4.970
- Reading 7(D):FP5,AR137.2144,ZE90.2525,SD112.5595--IRS,HR4.970
- Reading 7(R):FP5,AR317.2145,ZE269.3440,SD112.5592--IRS,HR4.970
- Reading 8(D):FP5,AR137.2144,ZE90.2525,SD112.5595--IRS,HR4.970
- Reading 8(R):FP5,AR317.2146,ZE269.3440,SD112.5598--IRS,HR4.970
- Reading 9(D):FP2,AR195.0047,ZE90.0758,SD280.6678--IRS,HR4.970
- Reading 9(R):FP2,AR15.0046,ZE269.5209,SD280.6671--IRS,HR4.970
- Reading 10(D):FP2,AR195.0048,ZE90.0758,SD280.6674--IRS,HR4.970
- Reading 10(R):FP2,AR15.0048,ZE269.5209,SD280.6671--IRS,HR4.970
  
- StDev:NO.0061,E0.0103
- Dist RMS:0.0205
- Ang RMS(Sec):14.8409
- Elev RMS:0.0021

# Create a Model

- ELEMENTS USED TO CREATE A MODEL
- COGO Points consist of:
  - Point Number – Location that can be recalled for point geometry
  - x,y,z – Location
  - Descriptor or Reactor – one of the most powerful elements in the file
- The description defines:
  - Symbol type
  - Line Type – line, 2d polyline or 3d polyline, breakline, etc.
  - Line Weight
  - Line color
  - Layer
  - Point Group – organizes the points into groups such as EP or Ground shots
- Intelligence attached to the point descriptor includes:
  - Automated drawing in the CAD file or Field Data Controller
  - Attaches a companion code – i.e., utilities – draw a line from a comm. Pedestal to a comm. MH to a UT pole for overhead comm.
  - Defines if the element is a surface element for modeling or a non-surface like a wall shot
  - Defines the method of drawing – i.e., from nearest point to nearest point or sequential points
  - Defines whether the CAD elements are to be separated – i.e., separate point number layers and description layers
  - Defines if the object is a single point object or double point object – a double point object can be a MH where the first point is the center and the second point is the outside edge – same for catch basins

# Create a Model

- Creating A Project Model
- All Design lines that can be a breakline should be a breakline
- Incorporate the Construction Survey tie in data
- All parts of the project that can be defined by a roadway template should be defined by a roadway template.
  - Normal Sections
  - Transition/taper lanes
  - Bifurcated or split baseline
  - Roadway intersection
  - Superelevation Transitions
- The fewer the points the better for the model.
- BUT, stakeout needs the points

# Machine Control

- The file type that we load into the on-board computer depends on the machine controller software.
- All Models should be Surface models. The surface is generally the best common reference point for the AMG and the stakeout.
- Dialing Down is the process that the operators will use to grade the base or sub base materials.
- There is almost always some amount of traditional stakeout that takes place. Usually in transitions or tight curves where hand work takes place.

# AMG and Stakeout

- The most common thing I hear that's not true is that the stakeout points are in the model. It's not true and creates lots of misunderstanding.
- A model in its most basic form is a grading tool, or a form of vertical control. A model is really a single entity made up of nodes. Nodes are positions, but have no intelligence.
- The Model Is Really The Triangle Faces
- The 3d Model Can Be Used/Should Be Used As The Vertical Base For The AMG And The Stakeout
- COGO point numbering should also be grouped together:
  - Control points 1-100
  - Baselines 101-110
  - Design EP 200-261
  - (etc.)
- THE object is to organize the file so the stakeout guy can find the points.