The Technical Side

Instrument Transport & Storage Methods

By Martin Cook, Vice President, Ingenuity, Inc.

Many surveying instruments are subjected to transport conditions that can be very damaging. Most surveys are usually not done on the street, but in the rough, rocky terrain of an undeveloped area or parcel. The typical vehicle that you are transporting your precision equipment in is a truck, not a luxury sedan. The typical rough ride can beat the heck out of you, not to mention your equipment. Even moderate jostling and vibration can cause damage to improperly stowed and protected equipment. The least amount of movement generally is at the middle or centre of the vehicle - where the crew rides. The best place for your equipment is near the centre, in the middle of the vehicle, not by the tailgate, the roughest hard-sprung place in the vehicle. Using padded boxes for all equipment is typical of conscientious surveyors. All equipment should be properly positioned and secured. Does your prism pole ride with the rebar and hammers, near the tailgate? Do your tripods have their caps in place to protect the head surface? Take a ride at the tailgate on a rough site and listen to the sound of the equipment! There shouldn't be any sound or movement.

How do you best protect the tools of our trade? Presented here are a few suggestions covering levels, theodolites and electronic total stations.

Auto Levels

Automatic levels contain a mechanical device that provides a level line of sight with moderate mislevelling. The most common precision compensator is the four wire pendulum or glider. When the level is upright in its operating position the compensator does what it is designed to do - it moves to compensate line of sight and is limited by stops on each end of its travel. The compensator can be constantly moving when transported, and may be moving enough to be banging on the stops. This constant banging can cause intermittent sticking due to degradation of the stops themselves. The best way to prevent compensator movement is to invert the unit so that the suspension wires are relaxed. In the past, instruments such as the Wild NA-2 or Zeiss Ni2 used to be placed in their cases so that they were transported upside down or face down. Many modern levels are no longer cased in this manner. It is up to the user to properly prepare the level for transport.

"Even moderate jostling and vibration can cause damage to improperly stowed and protected equipment."

Optical Theodolites

Theodolites with mechanical vertical angle compensators are subject to the same potential damage as an auto level. You can check for a mechanical compensator by slowly rocking the theodolite back and forth from vertical with the telescope in line with the rocking motion. If you can hear a clicking sound as the unit is rocked, it probably has this type of compensator. These units should be transported face down to minimize compensator movement. One transit/theodolite type with non-mechanical compensators are the Wild T-1 & T-1A. These have an oil compensator and should always remain upright to keep the oil off the upper surface of the compensator assembly. If you observe that the vertical circle image is blurry, there is probably oil on the upper view port. The condition will correct itself after setting in an upright position for a period of time. Transit and theodolite tangents should be lightly locked to prevent vibration damage to the bearings. This procedure is discussed in the next section.

Electronic Total Stations

Most compensators in electronic total stations (ETS) are electronically sensed capactive level vials and are not subject to motion damage. This fluid is compensated for temperature and linear level run characteristics by the system microprocessor. Topcon ET-1 and ET-2 and Zeiss Elta 2 and Elta 3 use an oil reflective level compensator which is not subject to motion damage. Mechanical pendulum compensators such as those used in Wild TC-1600 or the Nikon DTM-1 should be transported face down to limit movement.

Our main concern in transporting most ETSs is not the compensator but the bearings and end play at the angle encoders. For some reason, manufacturers have constructed the instrument case so that the carry handle is to one side of the ETS. This leads to the ETS being transported, not only by hand but also in the surveyor's vehicle, on its side. When the instrument is on its side, the weight of the telescope and distance meter pod (4-8 lbs.) is putting transverse weight on the trunnion axis (telescope axis) bearings. This is not only bad for the bearing surfaces but also for the angle reading statorrator systems. These two pieces of glass are adjusted to a gap of .0lmm (less than .0005 of an inch) by the mount of the stator. When the rotor, which is attached to the telescope axis, moves back and forth laterally, the gap may become too large or too small, causing the stator and rotor to touch. Contact can destroy the photo etched markings that allow the system to count and display angles correctly and accurately. Most systems use this type of angle measurement with the exception of the Topcon ET-1 and ET-2, Wild T-1000 and TC-1600 and a few others. These latter instruments have an angle reading system that is know as an absolute reading system. These units have an angle encoder which is a greater distance (+/-5mm) from the detector. While there is not the close proximity of a stator and rotor, it doesn't mean that these won't be subject to error due to telescope axis movement; it just means that transport position is less critical.

Back to the carrying case: Instruments with encoders are best transported with the stator and rotor systems on end: that means, for almost all ETSs, face down. You will have to determine the proper positioning of the case for transport. It will probably not be the same position used to hand carry the ETS.

Now that the ETS is face down and the angle reading systems are protected, we must address vibration damage. Do you lock the motions or not? Old school says leave them loose. When loose, the stator and rotor systems are allowed some movement to and away from each other. We feel that the tangent locks should be lightly tightened to prevent the bearings from vibrating, while still allowing the motions to be moved by a hard shock. When snugged up, the movement is limited. Forcing the motions to rotate when the tangents are lightly tightened will not damage the equipment. These instruments are designed so that the angle reading systems are a separate assembly which is independent of the clamping mechanism forces. If the motions are left loose, there can be some movement that can cause bearing and retainer wear in a small area. If this wear occurs, the linearity and repeatability of the instrument can be degraded.

As always, remember ... take care of your equipment and it will serve you well.

If you have any questions about a specific instrument or would like to comment on this article, I can be contacted at The Technical Side, 1562 Linda Way, Sparks, NV 89431, or you may fax correspondence to (702) 359-6671. isto

For information on ISTO Membership, contact:
Brian Munday, General Manager
c/o ISTO, 1043 McNicoll Avenue
SCARBOROUGH, Ontario
M1W 3W6

The Technical Side

Dual Axis Compensators

By Chris Cothrun, Service Technician, Ingenuity, Inc.

This time around we are discussing dual axis compensators. The HP 3820 was one of the first instruments to incorporate a dual axis compensator. Since then, many total stations offer this feature. In this article we will discuss the benefits and some things to watch out for with a dual axis compensator.

First, I'll provide some background information. When you set up your instrument you use the plat vial, which is usually no more accurate than 30 seconds per division. This typically allows levelling the instrument to within 10 seconds of absolute level. A single axis compensator, found on all but the most inexpensive total stations and theodolites, corrects the vertical angle for variations in levelling. Without it, the zenith angle is no better than the accuracy to which the instrument was levelled. The compensation axis is always in the same direction that the telescope is aimed. A dual axis compensator adds a compensation axis perpendicular to the vertical compensator. This is used to correct the horizontal angle when the instrument is not perfectly level and the telescope is inclined from horizontal. Picture an instrument set up badly out of level. When you transit the telescope the line of sight will not be perpendicular to the level plane. This introduces an error in the horizontal angle that depends on how far out of level the instrument is and how far from horizontal the telescope is. If your instrument is 30" out of level and your telescope is 10 degrees from horizontal the error would be 5". Increase the telescope attitude to 30 degree and the error increases to 17". Double the amount the instrument is mislevelled and the error doubles. The second axis in the compensator corrects for these errors.

This is used to correct the horizontal angle when the instrument is not perfectly level and the telescope is inclined from horizontal.

Sounds good so far, right? It even gets better. With a dual axis compensated instrument, a direct reading of the compensators is available. With this you can easily level the instrument to within five seconds of absolute level. You can also easily check the level to make sure your instrument hasn't changed its position.

What about problems? When the instrument changes level the compensator corrects for the change and affects the horizontal angle displayed. If this happens while you are turning angles and you try to check your backsight the azimuth to the backsight will be different. If you try to re-sight a point previously sighted, the azimuth displayed will not match the one previously measured. When this happens, try re-levelling the instrument. If the error was actually due to the level changing, the azimuth should match again. The actual angle measured from your backsight to a foresight should not change. If the angle is changing, look for errors beyond levelling.

We hope this article helps you understand your equipment better and lets you achieve greater accuracy in your work. Please send any questions to... The Technical Side, 1562 Linda Way, Sparks, NV 89431, or fax them to 702/359-6693. isto