On the Temperature Dependence of Gyroscopic Measurements Using the GYROMAT 2000

Prof. Fritz K. BRUNNER and Dr. Ekkehart GRILLMAYER, Austria

Key words: Gyroscopic measurements, temperature correction, system calibration, Gyromat.

ABSTRACT

Precise azimuth measurements using gyroscopes have become indispensable for large underground construction projects. Currently, the most advanced gyroscope is the fully automatic DMT GYROMAT 2000 which is a very robust instrument, requiring a short measurement period (<10 minutes) and designed to yield high precision azimuths with a standard deviation (std) of 7^{cc}.

Several ongoing large tunnel projects are associated with high temperature differences up to 50°C between the surface and the tunnel. Investigations elsewhere have indicated that the results using the GYROMAT 2000 may be plagued by uncompensated temperature effects. This is a very critical issue for underground azimuth transfers.

Therefore the accuracy and the effectiveness of the temperature corrections of the GYROMAT 2000 were investigated. For this purpose we designed and built a calibration facility for the system calibration of gyroscopes. Using a climatic cell, test measurements were carried out in the temperature range from –10°C to 40°C. The azimuth variations over the whole temperature range were studied with these datasets. Using the standard temperature compensation provided in the GYROMAT 2000, a std of the azimuths of 11^{cc} was obtained. This corroborates the findings by other laboratories about the temperature dependence of the GYROMAT 2000 results.

We report the results of a system calibration during a five day period with temperature variations between -10°C and 40°C. The internal temperature corrections of the tested GYROMAT 2000 were disabled. Using this data set, we can show that a simple second order polynomial correction function already yields almost unbiased azimuth results for the full temperature range. The elimination of the first observations of every group of azimuth measurements leads to further accuracy improvement, with a std of 6.9^{cc}.

CONTACT

Prof. Fritz K. Brunner
Engineering Geodesy and Measurement Systems
Graz University of Technology
Steyrergasse 30
A-8010 Graz
AUSTRIA
Tel. + 43 316 873 6321
Fax + 43 316 873 6820
E-mail: brunner@ivm.tu-graz.ac.at
Web site: http://www.cis.tugraz.at/ivm/

Dr. Ekkehart Grillmayer
Verbundplan Prüf- und Messtechnik GmbH
Rainerstrasse 29
A-5021 Salzburg
AUSTRIA
Tel. + 43 6547 7151 23254
Fax + 43 6547 7151 123254
E-mail: GrillmayerE@verbund.at
Web site: http://www.verbund.at