How does it work?

There are over 100 permanently operating ‘active’ GNSS stations in the OS Net® network. Their positions and heights are monitored continuously. There is also an extensive network of over 900 ‘passive’ GNSS control stations which have been heighted with GPS historically by the Ordnance Survey.

The system works by comparing the satellite data being received by your site receiver with the data being received at the OS Net® stations. From this, it calculates the coordinates of your receiver in the European Terrestrial Reference System 1989 (ETRS89). To convert the height component of these coordinates to height above ODN, Ordnance Survey publishes a transformation model, currently OSGM02, which should be included with the receiver/processing software. (For more information and extensive web resources see www.ordnancesurvey.co.uk/oswebsite/GNSS/). It is important to record, with the survey results, which height transformation model was used to ensure backward compatibility if and when new height models are released.

And the pitfalls?

GNSS measures the height at a moment in time. Every time you measure a point you are effectively re-levelling it, so each reading will reflect the system inaccuracies present, seasonal issues, long-term ground movements and in some areas ocean tide loading variations. Really precise observational methods can determine long term ground movements to within a centimetre.

Compared with conventional levelling, GNSS has a very high absolute accuracy with respect to the National Datum but low relative accuracy over short distances. For this reason, GNSS should be used to bring an Ordnance Survey datum height into a site and then traditional instrument levelling used to transfer that height around the site.

GNSS is black-box technology. It is easy to obtain an answer but not so easy to check its reliability. In areas where there has been no ground subsidence, levels derived from BMs agree with GNSS-derived levels to within 0.1m or better. Levelling GNSS BMs from traditional BMs is a useful check against gross errors.

This client guide is one of a series from the MAPP Panel of RICS geomatics, the full series and professional guidance can be downloaded from www.rics.org/mappp

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Geomatics client guides

Virtually level

Transition from traditional benchmarks to heighting using GNSS

Overview

Although specific to Great Britain the text of this client guide is relevant to those countries where similar transitions are or have already taken place. For the purposes of this guide, the new generic term Global Navigation Satellite System (GNSS) replaces the more specific term Global Positioning System (GPS).

Remember benchmarks?

Life used to be simple and most people associated with architecture, civil engineering, or property were familiar with Ordnance Survey benchmarks (BMs) cut into buildings and other structures. Each BM was at a known height above mean sea level, as measured at Newlyn in Cornwall (Ordnance Datum Newlyn or ODN) for mainland Britain or local datums for some outlying islands.

Ordnance Survey showed the BMs on their large-scale maps and published BM lists containing the altitudes and descriptions. National mapping agencies in other countries adopted similar policies.

Up until recently users took these BMs on trust. If in doubt it was simple to check one BM against a neighbouring one, using a level and staff.

The beauty of the BM network was that it gave straight forward physical altitudes above Ordnance Survey datum. You could transfer a height from any BM to find the altitude of features on a site using simple level and staff technology.

The old adage is still true: If it ain't broken, don't fix it. However, eventually everything starts to wear out and not perform as required. The point has been reached where the cost of restoring the BM network cannot be justified when compared with the benefits obtainable from modern technology.

Why change?

Ordnance Survey has not field-checked the BM values for many years, but the half-million strong network is still of good quality in most places. There has been variable ground movement in some regions throughout Great Britain to the point where BMs have become unreliable, especially in areas of previous mining activity. One of the main issues with continuing to maintain the BM network is the enormous costs involved.

BM values have been withdrawn from Ordnance Survey's OS MasterMap® product and BM lists are now no longer for sale. BM information is however now available at no cost from **www.ordnancesurvey.co.uk/benchmarks**

Whilst BM information is useful for checking purposes and for historical comparison, GNSS has developed sufficiently to provide a better consistency and absolute heighting accuracy across the country. Relating altitude to the mean sea level at ODN has traditionally been by means of the BM system, which provided BMs with a defined value for public use.

This has now been replaced by a height transformation model for the entire country which relates mean sea level heights to GNSS observations. However, it is no longer a case of just taking a value supplied by Ordnance Survey; users now have to have a reasonable understanding of how to use the software and hardware associated with precise GNSS observation.

GNSS is fundamentally a new approach to the heighting problem, which will help achieve a nationwide consistency.

This leaflet should assist you to understand it better.

What do you need to do?

You can establish GNSS-based heights by one of two methods. Both use a survey grade GNSS receiver and only work reliably when it is set up in a location with an unobstructed view of the sky.

The first method is suitable for any construction work where it is essential to establish a physical BM so you have a fixed reference point on the ground to which subsequent work relates. Set a tripod mounted GNSS receiver over a suitable ground point and collect data from the GNSS satellites for several hours.

As a rule, the longer the observation period, the more accurate the result should be. GNSS data for the same period should be downloaded from the Ordnance Survey website for a minimum of three OS Net® GNSS Active stations, and the two datasets post processed together. With care, the resulting height of the BM will be correct to better than a centimetre or two. Higher accuracies can be obtained by observing over several days. (Guidelines for the use of GNSS in surveying and mapping, guidance note, 2ed 2010 includes full details).

The second method is to observe heighted points in real time using a Networked Real Time Kinematic (RTK) system. Using a GNSS receiver fitted with a mobile phone SIM card you can go to site, connect to the network correction via a mobile telephone link and determine coordinates to an accuracy of a few centimetres within seconds. Use of this second method is best limited to those with a thorough understanding as it is a rapidly developing technology.

(See geo client guide: Virtually Right? – Networked GNSS, cost effective networked GNSS corrective services).