Leveling By Differential Global Position System (Case Study)

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Abstract: Using the differential Global Positioning System (DGPS) to determine the difference of elevations of two benchmarks (BM-1) and (BM-2) by static observation, check this method by traditional leveling (Differential Leveling). The difference between (ΔZs) of elevation between benchmarks was at worst situation (0.011) m, the leveling by (DGPS) not safe without check method. The (DGPS) method fast and cheap.

Introduction

Use the differential Global Positioning System (DGPS) for leveling in Iraq is not easy method, the reference elevation mathematical model (vertical datum) which used it is not best fit for Iraqi region, therefore the specialist use the global one (EGM-200) and its mathematical model was designed not for this area. In Iraq there is a big need to describe a best fit ellipsoid to conform the observations adjustment for any engineering project deals with geomatics. This situation never refuse to make a tic sign to describe the matching between the (DGPS) observations and the traditional methods in some of regions in Iraq, so to say that the step of describe a mathematical elevation model is not impossible, and the (DGPS) tool is not so far of leveling , therefore this paper prepared.

Differential GPS

The differential positioning depend on two as minimum GPS receivers, at least one of them its (X,Y and Z) are known. The computation of the second receiver position was differentially being correct. There are several methods to differential correction, usually here there use a commercial service (OPUS: Online Positioning User Service), that collects the data from GPS at several sites and weight them to produce optimum set of corrections. These corrections provides at real time observations, were they automatically applied to data collected by GPS roving receivers, for long time a static observations were used for geodetic or for control points.[1]

(DGPS) Observations

Using the instrument (EPOCH50) with radio, the base part of this instrument has been established on the point (BASE_1) for a long time and more than once. Transport the elevation from the Poleservice which represent the official national elevation, for duration time thirty minutes. The bench marks where observed at ten minutes duration. All observations done with complete (DGPS) installation requirements, the most option installation deals with paper subject it is the geoid that used for observations, the Earth Gravity Model (EGM08). The recent settings shows in the sample of processing report captured by the web suite (OPUS: Online Positioning User Service), Figures (1and 2).[2]

Traditional Leveling (Differential Leveling)

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Use the instrument Leica NA720 for leveling between bench marks, fix a turning points in equal distances back sight with fore sight for every one of them, that's between (BM-1) and (BM-2), the turn back from (BM-2) to (BM-1) in the second loop for close the leveling work. The closure error with respect to the eyes reading on rod can be neglected.

Data Computations and Analysis

The elevation used by the (DGPS) is a global elevation, where it is had a pad accuracy as vertical observations, but when (DGPS) supplied the local elevation for base point, the observation can be adjusted and used with acceptable results. The difference (ΔZ) of elevation between (BM-1) and (BM-2) was computed (0.484) m, using (DGPS), table (1). The difference (ΔZ) of elevation between (BM-1) and (BM-2) was computed (0.49) m, using traditional leveling, table (2).

The comma digits for results by (DGPS) method are more than three digits, the comma digits for results by traditional method depends on eyes accuracy here, as about (0.005) m, this make the probability of (0.49) m is (0.485) m or (0.495) m as a result. To compare the two methods results. Then we must take the worst one which is (0.495) m, that give us the result (0.011) m as difference between (ΔZ) of elevation between (BM-1) and (BM-2) came's from the two methods (DGPS) and the traditional (Differential Leveling).

Table (1) DGPS Observations

Field Code	Point Code	E	N	Z	Note
n524	KUO9	479453.6	3643259	27.571	Poleservice
4	BM-1	469930	3644484	27.947	Bench Mark
y305	BM-2	469098.4	3644965	27.463	Bench Mark
Base_1	-----	468214.8	3645418.5	27.347	Base Part
Elv. Difference (ZBM-1)-(ZBM-2)				0.484	

Table (2) Traditional Leveling

Point	B.S.	F.S.	HI	Assumed Elv.		
BM-2	1.86		11.86	10		
TP1	1.35	1.325	11.885	10.535		
TP2	1.38	1.495	11.77	10.39		
TP3	1.43	1.51	11.69	10.26		
TP4	1.5	1.415	11.775	10.275		
TP5	1.65	1.33	12.095	10.445		
TP6	0.49	1.49	11.095	10.605		
BM-1	0.605	0.605	11.94	10.49		
TP6	1.52	0.49			Elv. Difference	0.49
TP5	1.45	1.68				
TP4	1.39	1.62			Z33-Z43	

TP3	1.4	1.405				
TP2	1.52	1.27				
TP1	1.6	1.375				
BM-2		2.135				
	Sum.BS	Sum.FS				
	9.66	9.17		0.49	First Loop BSs-FSs	
	9.485	9.975		-0.49	2nd Loop BSs-FSs	

Conclusions:

1) Always use the (DGPS) need an another check method.

2) There is an indication that makes us think there is an mach between the geoid and the earth surface in this coordinated area.

3) Prepare to work on the vertical datum is not too difficult.

References

[1] Barry F. Kavanagh., (2006). "Surveying Principles and Applications", Upper Saddle River,New Jersy,Ohaio.
[2] Authors: **Lu**, Zhiping, **Qu**, Yunying, **Qiao**, Shubo., (2014). " Introduction to Geodetic Datum and Geodetic Systems".
[3] Web Suite, https://www.ngs.noaa.gov/OPUS

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Project Information		Coordinate System	
Name:		Name:	UTM
Size:		Datum:	WGS 1984
Modified:	2/15/2012 8:45:59 AM (UTC:-7)	Zone:	38 North (45E)
Time zone:	Mountain Standard Time	Geoid:	EGM_2008_(Global)
Reference number:		Vertical datum:	EGM_08
Description:			

Baseline Processing Report

Processing Summary

Observation	From	To	Solution Type	H. Prec. (Meter)	V. Prec. (Meter)	Geodetic Az.	Ellipsoid Dist. (Meter)	ΔHeight (Meter)
n524 (B1)	BASE_1	n524	Fixed	0.007	0.018	100°41'27"	11448.809	0.234
4 (B2)	BASE_1	4	Fixed	0.006	0.012	118°23'22"	1953.793	0.899

Acceptance Summary

Processed	Passed	Flag	Fail
2	2	0	0

BASE_1 (11:23:26 AM-11:54:38 AM) (S1)

Baseline observation:	n524 (B1)
Processed:	7/14/2015 3:38:18 PM
Solution type:	Fixed
Frequency used:	Dual Frequency (L1, L2)
Horizontal precision:	0.007 m
Vertical precision:	0.018 m
RMS:	0.002 m
Maximum PDOP:	2.125
Ephemeris used:	Broadcast
Antenna model:	Trimble Relative
Processing start time:	7/13/2015 11:24:08 AM (Local: UTC+3hr)
Processing stop time:	7/13/2015 11:54:18 AM (Local: UTC+3hr)
Processing duration:	00:30:10
Processing interval:	1 second

1

Vector Components (Mark to Mark)

From:	BASE_1				
Grid		Local		Global	
Easting	468214.822 m	Latitude	N32°56'47.76680"	Latitude	N32°56'47.76680"
Northing	3645418.548 m	Longitude	E44°39'35.82287"	Longitude	E44°39'35.82287"
Elevation	27.075 m	Height	24.075 m	Height	24.075 m

To:	n524				
Grid		Local		Global	
Easting	479453.592 m	Latitude	N32°55'38.61587"	Latitude	N32°55'38.61587"
Northing	3643259.224 m	Longitude	E44°46'48.84378"	Longitude	E44°46'48.84378"
Elevation	27.660 m	Height	24.309 m	Height	24.309 m

Vector					
ΔEasting	11238.770 m	NS Fwd Azimuth	100°41'27"	ΔX	-7092.068 m
ΔNorthing	-2159.324 m	Ellipsoid Dist.	11448.809 m	ΔY	8808.100 m
ΔElevation	0.585 m	ΔHeight	0.234 m	ΔZ	-1787.772 m

Standard Errors

Vector errors:					
σ ΔEasting	0.003 m	σ NS fwd Azimuth	0°00'00"	σ ΔX	0.007 m
σ ΔNorthing	0.003 m	σ Ellipsoid Dist.	0.003 m	σ ΔY	0.006 m
σ ΔElevation	0.009 m	σ ΔHeight	0.009 m	σ ΔZ	0.005 m

Aposteriori Covariance Matrix (Meter²)

	X	Y	Z
X	0.0000441844		
Y	0.0000321347	0.0000347822	
Z	0.0000250500	0.0000221110	0.0000231389

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