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STUDY THE EFFECT OF SUN DIRECTION AND BATTERY CAPACITY ON DEFLECTION MEASUREMENTS FOR REFLECTORLESS TOTAL STATION

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ملخص البحث :

وحدة القياس المتكاملة بدون عاكس (Reflectorless total station) تستطيع الحصول على المعلومات عن طريق الاشارة التى ترتد من الاسطح مباشرة دون الحاجة الى عاكس (prism) وتطوير هذه التقنية يساعد كثيرا فى الحصول على البيانات والمعلومات بسرعة وبدقة مما يودى الى توفير الوقت والجهدوخاصا فى مجال الهندسة المدنية ومثالا لذلك هذه المعلومات تخدمنا فى التعرف على مقدار التشوة او الهبوط التى تحدث للمبانى أثناء الانشاء او من خلال حوادث عرضية .ولذلك يستمر الباحثون فى التعرف على العوامل التى توثر على دقة النتائج أثناء القياس سواء المسافات او الهبوط او التشوه .وهدف هذه الدراسة هو التعرف على مدى تاثير اشعة الشمس على دقة النتائج والحكم عليها وايضا معرفة تاثير شحن البطارية للجهاز المستخدم على القياسات من خلال الرصد على سطح مائل بميل 1:2 و1:4 ونقوم بالتحكم فى هبوط هذه السطح يدويا ومعرفة قيمة الهبوط من خلال الساعة الدقيقة (dial gauge) ويتم قياس المسافة بعد الهبوط بالمسافة قبل الهبوط وحساب الفرق والحكم على النتائج ومن خلال تحليل النتايج والبيانات تم الوصول الى أن عندما يكون السطح العاكس فى عكس اتجاة الشمس يعطى نتائج اقل دقة من الرصد فى نفس اتجاة الشمس وعندما تكون بطارية الجهاز المسخدم كاملة الشحن تكون النتائج أكثر دقة من النتائج عندما تكون مستوى الشحن منخفض

الكلمات المفتاحية: جهاز المحطة المتكاملة ، الهبوط، التشوة، السطح العاكس

1 Abstract.

Reflectorless EDM technology uses phase measuring or pulsed lasers to measure targets of a reflective and non-reflective nature. Reflectorless distance measurement provides rapid measurement by saving time and labour for surveyors. However, the accuracy of these types of measurements is under question because of the variety of constraints that affect the measurement. This paper aims to study the effect of sun direction and battery capacity on the reflectorless total station measurements, in particular the deflection. So in our study we used targets with different slopes, such as a slope of 1:2 and 1:4 in distance measurement due to deflection, which we controlled from our side to get results with a higher level of precision than the results that come from total station with ordinary targets.

We noted that the battery capacity has a great effect on the accuracy of measurements because some of the results were not accurate with low battery capacity. Also, the percentage of error was too high in measurements with the sun direction and was accurate against the sun direction.

Key words: Deflection, Measurements, total station, Reflectorless, Accuracy

2 1. Introduction.

The total station is an example of this technology. It is an electronic/optical tool used for surveying and building construction that measures distances by combining EDM units and measuring vertical and horizontal angles. With an accuracy of 3 mm, modern total stations can measure unreachable targets. In measuring distance there are two main methods (the prism, and the non-prism method). The prism method depends on a prism on the target point to reflect the signal to the EDM unit again and the distance measured by the time taken from the EDM to prism plus from prism to get back the EDM again, but in the non-prism or Reflectorless method we can measure distance and surveying are without using a prism and depend on the surface which exists in the area to reflect the signal to the EDM again, we can measure distance and survey without using a prism and depend on the surface that exists in the area to reflect the signal to the EDM again. The ability to measure inaccessible points with such reflectorless total station instruments is their greatest benefit, as it enables us to collect data more quickly and mark up points in the field with greater speed and accuracy.

Studies investigated the effects of materials [1] and colours [3] [4] on Reflectorless total station measurements in short distances, while there were rashers studied the effects of materials and colours in long distances [2], and some of these studies used Reflectorless targets with different title angles from 5 to 60, while the others used title angle zero in all studies but the target was vertical. The total station is used to determine vertical displacement [5]and also for quantification of systematic distance deviations under incidence angle [6], determination of pipe line deflection [7], and R.C beam deflection [8]. In our study, we made a target with a slope of 1:4 and 1:2 to control the deflection value and checked if the measured value was the same as the calculated value or not.

1. Experimental Work.

1.1. Program.

In this work, we will investigate the effects of using a reflectorless target with slopes of 1:2 on deflection distance measurements in and against the sun, with full and low battery capacity, by controlling the vertical displacement measurements and comparing the results shown in the table below.

1.2. Equipment’s work.

two total stations with different accuracy were used in our work the first one is SOKKIA IM with aprecise 2’’ second and the second one is Topcon GTS with aprecise 7’’ second, dial gauge was used to control in vertical movement of the Reflectorless target.

Figure (1) Reflectorless target with slope 1:2

Figure (2) Topcon GTS with precise 7'' second

Figure (3) dial gauge below Reflectorless target

Figure (4) Sokkia with precise 7'' second

work steps.

The study was done in simple steps.

- First, we fixed the reflector less target with a slope of 1:2 on a fixed stable barrier.
- Then we fixed the total station on the distance from the stable barrier and measured this distance by total, recording it manually and considering this distance as a reference for all measurements.
- The control in value of vertical movement of the reflectorless target surface was made by using a dial gauge to make the value as required. It was noted that (the complete circle of dial gauge equals 1mm vertical movement. This means when the reading starts from 0 to 100, there was a vertical movement with a value of 1mm occurred.
- Then we start to move the reflectorless target by vertical movement while watching the dial gauge reading. We stop the vertical movements when the reading becomes from 0 to 50, and then take the total station reading and record the new distance again.
- Repeat the previous step once again, but this time the dial gauge reading starts at 50 and ends when the reading becomes 0 again. Then take the total station reading and record the new distance due to this movement.
- We repeated this with interval 50 in dial gauge reading with other total station types and with different distances from the fixed barrier, which carries the reflector less target with a slope of 1:2.
- Compute the difference between the original distance (which is measured by the total station with prism) and the new distance due to the vertical movement of the reflectorless target at each time interval.
- Repeat all previous steps with a different slop of 1:4 with the same previous distance but this time with interval 25 in dial gauge reading with other total station types and with different distances from the fixed barrier which carries the reflector less target with a slope of 1:4
- And finally, check the results to know that at each distance the total station reading is the same and no change appears in the results of the measured distance even after we continue in the vertical movement for the reflectorless target. This means at this distance the change in slope surface of the reflectorless target does not affect displacement measurements.

2. Study the factor which affects measurement accuracy.

2.1. the effect of sun direction on the accuracy of deflection measurements with slope 1:2 by SOKKIA IM.

In our study, we checked the effect of the sun's direction on the accuracy of deflection measurements, with a fixed distance of 50.075 m in the sun's direction and 52.345 m against the sun's direction with reflector less target slope 1:2 and total stations Sokkia. We measured the deflection for the distance in the same way (vertical movement for the reflectorless target with a slope of 1:2) in the sun direction and against the sun direction and the results are in the below tables. We calculate the measured value from this formula:

$$D = E - V \quad \ldots\ldots (1)$$

Where

D: is the difference between the exact value and measured value for distance.

E: is the exact value or theoretical value for distance

V: is the measured distance or experimental distance which we get after deflection (in case of dial gauge reading a deflection value 0.5mm so the value of V should be 1mm in case of using a target with a slope of 1:2 and the)

Table (1) the results due to vertical movement with distance of 50.075 m with Sokkia IM with a of the slope of 1:2 in the sun direction.

Dial gauge vertical displacement (mm)	Variations in the distance (V) (mm)	Exact value(mm) (E)	Difference between exact value and measured value (D) (mm)
0.5	1	1	0
1	2	2	0
1.5	3	3	0
2	3.9	4	0.1
2.5	5	5	0
3	6	6	0
3.5	7	7	0
4	8.2	8	-0.2
4.5	9	9	0

Table (2) the results due to vertical movement with a distance 50.0756 m with Sokkia IM with a of slope of

Dial gauge vertical displacement (mm)	Variations in the distance (V) (mm)	Exact value(mm) (E)	Difference between exact value and measured value (D) (mm)
0.5	0.5	1	0.5
1	2.68	2	-1.68
1.5	3.84	3	-0.84
2	5.24	4	-1.24
2.5	6.8	5	-1.8
3	7.96	6	-1.96
3.5	10.64	7	-3.64
4	11.4	8	-3.4
4.5	12.44	9	-3.44

1:2 against sun direction

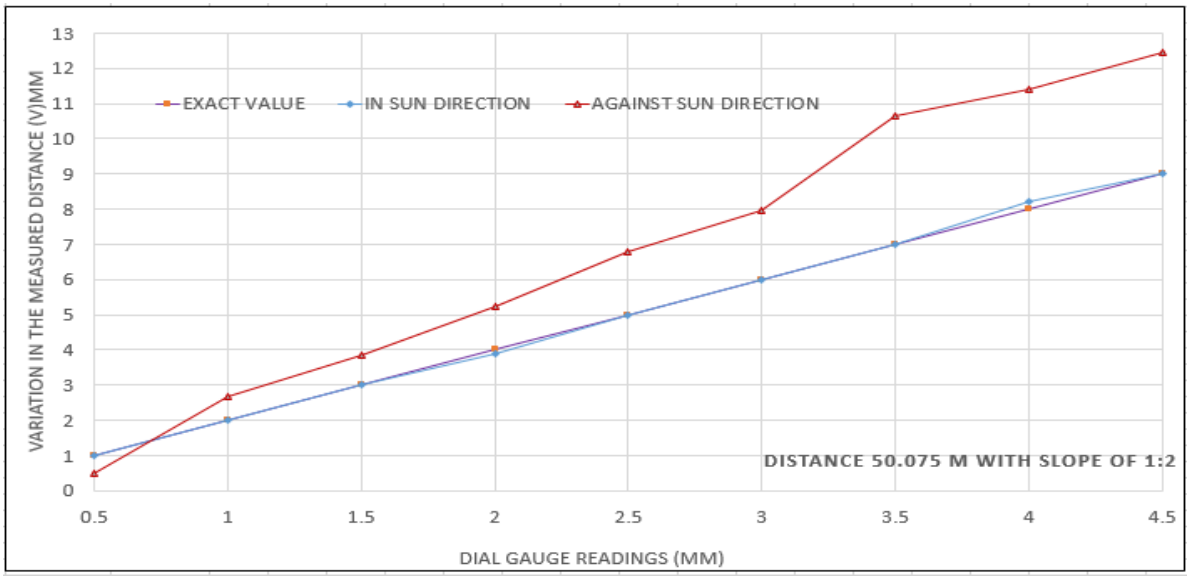


Figure (1) show the compression between difference of measured distance in sun direction and against sun direction with dial gauge reading

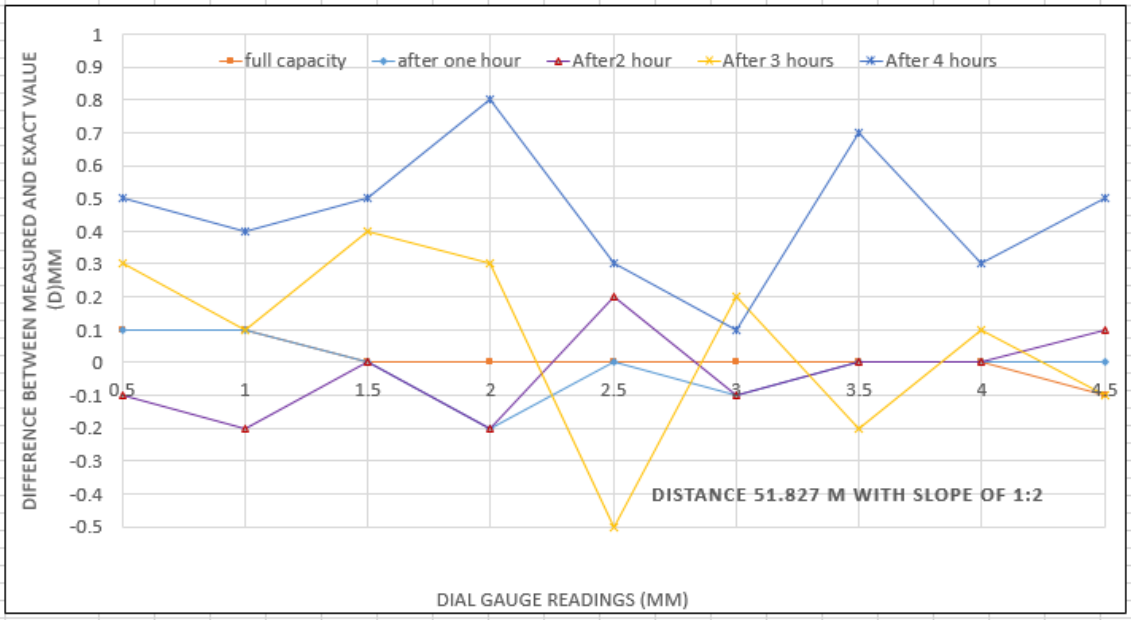
From Table (1,2) and figure (1). we can realize that the sun direction has a great effect on the accuracy of the results of deflection measures because in the sun direction the results were very accurate and the variation between the exact, and the measured value was a maximum of +0.2 mm but against the sun direction, the results were too bad and not accurate because of the variation between the exact and measured value become +3.44mm so we recommended to use the total station in deflection measurements with sun direction to get accurate results.

2.2. the effect of battery capacity on the accuracy of deflection measurements with slope 1:2 by Topcon.

In a previous study, the battery capacity of the total station's total station was found to have an impact on the precision of distance measurements; therefore, in our study, we will examine the impact of this factor on the precision of deflection measurements. To do this, we begin with a distance of 51.827 m with a full battery capacity and a Topcon total station with a precision of 7" seconds and a sloped surface of 1:2. After an hour, we repeat the measurements for the same distance and again after 2 hours with interval time 1 hour till the device power off and all recorded results were shown in below table and we create a graph to show the relationship between the vertical movement and difference in measured distance in below figures with different time.

Table (3) the results of Topcon total station with Reflectorless target with a slope of 1:2 for a distance of 51.8270 m with variable time

Dial gauge vertical displacement (mm)	Difference between the measured value and exact value(mm)				
	full capacity	1 hour	2 hour	3 hour	4 hour
0.5	0.1	0.1	-0.1	0.3	0.5
1	0.1	0.1	-0.2	0.1	0.4
1.5	0	0	0	0.4	0.5
2	0	-0.2	-0.2	0.3	0.8
2.5	0	0	0.2	-0.5	0.3
3	0	-0.1	-0.1	0.2	0.1
3.5	0	0	0	-0.2	0.7
4	0	0	0	0.1	0.3
4.5	-0.1	0	0.1	-0.1	0.5



Figure(2) compression between the same total station with different time according to the difference between the measured and exact value

Table (2) and figure (2) show that the battery capacity has a significant impact on the accuracy of the results of deflection measurements. When the battery was fully charged, the results were extremely accurate, with a +0.1 mm error between the exact value and the observed value. However, after just one hour the difference between the exact and measured value increased to 0.2mm, 0.5mm after three hours, and eventually, 0.7mm after four hours till the total station power down. As a result, we advised against using the total station to measure deflection at low battery capacity.

3. The conclusion.

- Why Using a total station with its full battery capacity increases the accuracy of deflection measurements and lowers the error percentage.
- The results of deflection measurements will be very poor and inaccurate if the total station's battery capacity is low or it is about to shut down.
- From the experimental work and after evaluating the data, we discovered that the precision of deflection measurements will be highly accurate and lower the error percent if the total station is pointing in the direction of the sun.
- The accuracy of deflection measurements will not be precise when the entire station observation occurs in opposition to the direction of the sun.

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