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THE EFFECTS OF GEODETIC CONFIGURATION OF THE NETWORK IN DEFORMATION ANALYSIS

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CONTENTS OF PRESANTATION

1. INTRODUCTION

The aim of deformation analysis is the detection; localization and modelling of point movements in multiply measured networks. Such an analysis provides valuable information about the deformations of physical and man-made objects on the earth surface.

"Optimized Measurement Plan"

An optimized monitoring scheme ensure the most economic field campaign, and it helps in identifying, eliminating, or minimizing the effects of the gross and systematic errors existing in the observation data prior to the estimation of the deformation parameters in order to avoid misinterpreting measuring errors as deformation phenomena.

In this study, the effects of configuration of Gerede micro geodetic network in deformation analysis were researched.

2.OPTIMIZATION OF GEODETIC NETWORK

In this study, the first measurement plan was optimazed according to aim function. As the aim function, it was researched the geometry that respond both the mathematical-statistical test and the first deformation values in deformation points. Therefore, the test statistic

$$T = \frac{\underline{d}_i^{T}\,\underline{Q}_{di}^{-1}\,\underline{d}_i}{2\sigma_0^2} \qquad (1)$$

was selected as the aim function.

3.DEFORMATION ANALYSIS

Any object, natural or man-made, undergoes changes in space and time. Deformation refers to the changes a deformable body undergoes in it's shape, dimension, and position.

- Separated Free Adjustment
- Combined Free Adjustment
- $tr(Q_{stabile,stabile}) = min$

In this study "The Relative Confidence Ellipses Method" was applied. All the observations in the two periods were adjusted together as free nets by taking as datum points, which were assumed to be stable with respect to each other. For this process the datum point coordinate unknowns were taken as a one-valued set, but the other points were considered as a two-valued set, each value corresponding to each period.

The difference vector between the coordinates estimated from the combined adjustment of the points P_i was written as

$$\underline{d}_i = \begin{bmatrix} d_{yi} \\ d_{xi} \end{bmatrix} = \begin{bmatrix} Y_{2i} - Y_{1i} \\ X_{2i} - X_{1i} \end{bmatrix} \qquad (2)$$

With the cofactor matrix $\underline{Q}d_i$, the test statistic was

$$T = \frac{\underline{d}_i^T Q_{di}^{-1} \underline{d}_i}{2\sigma_0^2}, F_{2,f;\alpha} \quad ; f = n - u + d_i \qquad (3)$$

Deformation vectors were computed from

$$d_{si} = \sqrt{dx_i^2 + dy_i^2} \qquad (4)$$

And their directions were computed from

$$\alpha_i = \arctg\left(\frac{dy_i}{dx_i}\right) \qquad (5)$$

4. NUMERICAL APPLICATION

In this study, the effects of configuration of Gerede micro geodetic network in deformation analysis were researched. The subject area is located on a fault line near Gerede around The North Anatolian Fault Zone (NAFZ) in Turkey.

The network established for the detection of possible crustal movements in the area covering 4.2 km² consists of 8 points. There are 23 distances and 48 directions measurement in Gerede micro geodetic network. The measurements were carried out between 1983 and 1985.

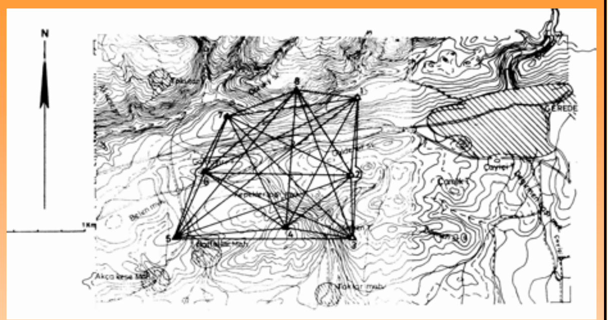

Figure 1: Configuration of the micro geodetic network in Gerede

Measurements

Distances Directions

- ACG1 → Adjusted coordinates that were carried off according to the first measurement plan
- ACG2 → Adjusted coordinates that were carried off according to the new measurement plan (when distance measurements were out of from the first measurement plan)
- ACG3 → Adjusted coordinates that were carried off according to the new measurement plan (when direction measurements were out of from the first measurement plan)

Finally, the differences both ACG1-ACG2 and ACG1-ACG3 were researched. Differences both ACG1-ACG2 and ACG1-ACG3 are given in Table 1 and Table 2.

Table 1: Adjusted coordinate differences when 1-3 distance measurement is out of from the first measurement plan.

Compt. 13	1983		1985	
	ACG1-ACG2		ACG1-ACG2	
PN.	dy(mm)	dx(mm)	dy(mm)	dx(mm)
1	-0,01	-0,04	-0,01	-0,13
2	-0,01	0,00	-0,03	0,00
3	0,00	0,03	-0,01	0,11
4	0,00	0,01	0,01	0,04
5	0,00	0,00	0,02	0,02
6	0,00	0,01	0,02	0,01
7	0,01	0,00	0,01	0,00
8	0,00	-0,01	-0,01	-0,04

Table 2: Adjusted coordinate differences when 1-3 direction measurement is out of from the first measurement plan.

Compt. 13	1983		1985	
	ACG1-ACG3		ACG1-ACG3	
PN.	dy(mm)	dx(mm)	dy(mm)	dx(mm)
1	-0,04	-0,10	-0,12	-0,29
2	-0,01	0,02	-0,01	0,07
3	0,14	0,02	0,44	0,07
4	-0,02	0,00	-0,06	0,01
5	-0,04	0,03	-0,13	0,10
6	-0,02	0,02	-0,05	0,05
7	-0,01	0,00	-0,05	0,00
8	0,00	0,00	-0,01	0,00

For this aim, alternately distance measurements were out of from the first measurement plan. According to new measurement plans free adjustment and analysis procedures were done. In the end of analyses, test statistic values were obtained.

These test statistic values were compared with the first statistic values that were obtained according to the first measurement plan. Finally it was decided that 1-3, 1-4, 2-3, 4-5, 4-6, and 5-7 distance measurements had lower effect in test statistic value.

Table 3: Test statistic values when 1-3 distance measurement is out of from the first measurement plan.

Compt. 13	First Situation	Second Situation
Critical Value	4,82	4,83
P.N	Test Statistic	Test Statistic
2	56,004	56,026
3	30,844	30,863
4	14,666	14,179
5	13,848	14,137
6	9,534	9,513

Table 4: Test statistic values when 1-4 distance measurement is out of from the first measurement plan.

Compt. 14	First Situation	Second Situation
Critical Value	4,82	4,83
P.N	Test Statistic	Test Statistic
2	56,004	55,672
3	30,844	29,304
4	14,666	14,622
5	13,848	13,909
6	9,534	9,236

Table 5: Test statistic values when 2-3 distance measurement is out of from the first measurement plan.

Compt. 23	First Situation	Second Situation
Critical Value	4,82	4,83
P.N	Test Statistic	Test Statistic
2	56,004	54,247
3	30,844	27,095
4	14,666	15,242
5	13,848	13,924
6	9,534	9,593

Table 6: Test statistic values when 5-7 distance measurement is out of from the first measurement plan.

Compt. 57	First Situation	Second Situation
Critical Value	4,82	4,83
P.N	Test Statistic	Test Statistic
2	56,004	56,016
3	30,844	31,448
4	14,666	15,179
5	13,848	11,484
6	9,534	10,119

Table 7: Test statistic values when 4-5 distance measurement is out of from the first measurement plan.

Compt. 45	First Situation	Second Situation
Critical Value	4,82	4,83
P.N	Test Statistic	Test Statistic
2	56,004	56,208
3	30,844	31,365
4	14,666	15,021
5	13,848	15,074
6	9,534	8,071

Table 8: Test statistic values when 4-6 distance measurement is out of from the first measurement plan.

Compt. 46	First Situation	Second Situation
Critical Value	4,82	4,83
P.N	Test Statistic	Test Statistic
2	56,004	55,856
3	30,844	29,464
4	14,666	14,489
5	13,848	12,964
6	9,534	8,904

In respect of these results, it was tried to be out more than one distance from the first measurement plan at the same time.

Table 9: Test statistic values when 1-3, 1-4, and 5-7 distance measurements are out of from the first measurement plan.

Compt. 13/14/57	First Situation	Second Situation
Critical Value	4,82	4,84
P.N	Test Statistic	Test Statistic
2	56,004	56,835
3	30,844	30,515
4	14,666	14,938
5	13,848	11,996
6	9,534	9,796

Table 10: Test statistic values when 1-3, 1-4, 5-7 and 2-3 distance measurements are out of from the first measurement plan.

Compt. 13/14/57/23	First Situation	Second Situation
Critical Value	4,82	4,84
P.N	Test Statistic	Test Statistic
2	56,004	58,508
3	30,844	26,513
4	14,666	16,280
5	13,848	12,575
6	9,534	10,475

Table 11: Test statistic values when 1-3, 1-4, 5-7, 2-3 and 4-5 distance measurements are out of from the first measurement plan.

Compt. 13/14/57/23/45	First Situation	Second Situation
Critical Value	4,82	4,85
P.N	Test Statistic	Test Statistic
2	56,004	58,027
3	30,844	26,301
4	14,666	15,868
5	13,848	12,859
6	9,534	7,434

Table 12: Test statistic values when 1-3, 1-4, 5-7, 2-3, 4-5 and 4-6 distance measurements are out of from the first measurement plan.

Compt. 13/14/57/23/45/46	First Situation	Second Situation
Critical Value	4,82	4,85
P.N	Test Statistic	Test Statistic
2	56,004	57,825
3	30,844	24,940
4	14,666	16,015
5	13,848	12,234
6	9,534	6,657

In the end all of these calculations, it was concluded that when 1-3, 1-4, and 5-7 distance measurements were out of from the first measurement plan, there were not important changes in test statistics in deformation points. In this way, the most satisfactory network configuration, which responds to the first deformation values in deformation points, was obtained.

Table 13: The results of the deformation analysis obtained from the first measurement plan.

Point Number	dY(cm)	dX(cm)	A-Konf(cm)	B-Konf(cm)	θ (gon)	d(cm)	t(gon)
2	-0,840	0,732	0,407	0,319	68,94	1,114	-54,36
3	-0,766	0,297	0,511	0,275	67,24	0,821	-76,40
4	-0,436	0,427	0,437	0,302	98,88	0,611	-50,68
5	0,007	0,547	0,806	0,297	328,72	0,547	0,88
6	0,008	0,441	0,466	0,278	340,16	0,441	1,16

Table 14: The results of the deformation analysis obtained from the last measurement plan.

Point Number	dY(cm)	dX(cm)	A-Konf(cm)	B-Konf(cm)	θ (gon)	d(cm)	t(gon)
2	-0,804	0,784	0,465	0,327	54,80	1,123	-50,82
3	-0,696	0,387	0,691	0,301	55,06	0,796	-67,73
4	-0,372	0,484	0,562	0,337	77,52	0,610	-41,73
5	0,043	0,622	0,987	0,359	334,61	0,624	4,44
6	0,036	0,452	0,506	0,282	342,76	0,453	5,00

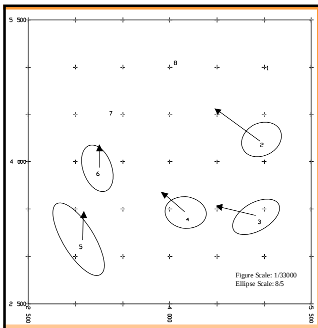

Figure 2: The horizontal displacement vectors between 1983 and 1985 together with 95% confidence ellipses according to the first analysis results that was done related to the first measurement plan.

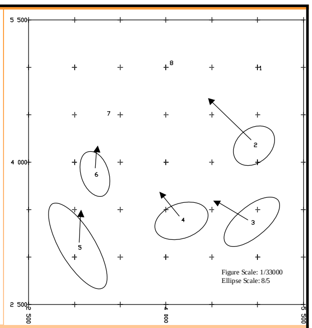

Figure 3: The horizontal displacement vectors between 1983 and 1985 together with 95% confidence ellipses according to the last analysis results that was done related to the last measurement plan.

5. CONCLUSIONS

In this study, the effects of geodetic configuration of the network in deformation analysis were researched. It was studied to get the most satisfactory network configuration that responds to the first deformation values in deformation points. In the last measurement plan, distance measurements were 13% decreased. Three distance measurements, 1-3, 1-4, and 5-7 were out of from the first measurement plan and the first measurement plan was simplified.

In the end of the deformation analysis that was done according to the last measurement plan, the largest movement occurred with 1.12 cm in the point number 2. The minor movement occurred with 0.45 cm in the point number 6. Finally, it is obtained that the last analysis results are the same with the first analysis results.

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THANK YOU FOR YOUR INTEREST

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