APPENDIX (B)

proposed design for leveling network.

Solution:

See (fig B1 & Table B1) - Page 93

Let the value of B.M= 00.00 and standard error =10√ k.

Let L be the true value of the observed height differences and

$\bar{X} = [\bar{X}_1 \quad \bar{X}_2 \quad \bar{X}_3 \quad \bar{X}_4]^T$

Be the true values of the height stations 1,2,3, and 4

Then we have the following observation equations ($f(\bar{x}) = \bar{L}$)

$L_1 = x_1 - B.M = 5.21$

$L_2 = x_2 - B.M = 1.90$

$L_3 = x_3 - B.M = -8.41$

$L_4 = x_4 - B.M = 2.93$

$L_5 = x_2 - x_1 = 3.27$

$L_6 = x_3 - x_1 = 13.58$

$L_7 = x_4 - x_1 = 2.18$

$L_8 = x_3 - x_2 = 10.21$

$L_9 = x_4 - x_2 = -1.13$

$L_{10} = x_4 - x_3 = -11.35$

We have

N = No of observations = 10

M = No of unknown = 4

R = N-M = redundancy = 6

Therefore the design matrix (A matrix)

$$A_{nxm} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -1 & 1 & 0 & 0 \\ -1 & 0 & 1 & 0 \\ -1 & 0 & 0 & 1 \\ 0 & -1 & 1 & 0 \\ 0 & -1 & 0 & 1 \\ 0 & 0 & -1 & 1 \end{pmatrix}$$

The b matrix

$$b_{nx1} = \begin{pmatrix} 5.12 \\ 1.90 \\ -8.14 \\ 2.93 \\ 3.27 \\ 13.58 \\ 2.18 \\ 10.21 \\ -1.13 \\ -11.35 \end{pmatrix}$$

To construct the weight matrix (w) we have
Standard error = 10√k or $\sigma = 10\ (k)^{1/2}$ where k is the distance in kilometers
Since $w = 1/\sigma^2$

$$W_{nxn} = \begin{pmatrix} 2500 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1300 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1100 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1600 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1400 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 885 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1075 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1802 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1429 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 2000 \end{pmatrix}$$