# 51. *On Variations in the Length of the Mitaka Comparison Base Line.*

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It was recently noticed that the length of the Mitaka 25 meter comparison base line varied as the air temperature varied. These constant changes being a serious matter, investigations were made with a view to ascertain whether they were due to constructional defects in connection with the original measurement of the base line or to actual movements of the earth's crust.

1. This base line was laid down in 1915. As the specifications covering the constructional work at the time of the original measurement was lost in the fire that followed the great 1923 earthquake, there is uncertainty about the exact underground construction of the terminal of the base line, but from such parts of the exterior as are visible, it seems that it was constructed in the same way as that of the Sagamino base line. See Fig. 1.

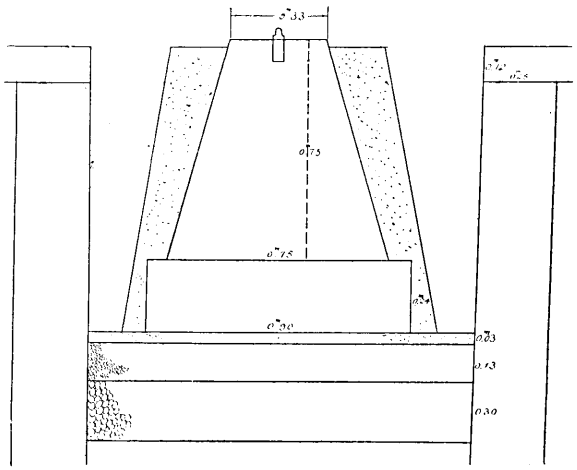

Fig. 1. Sketch of a terminal of the Base.

In 1931 the greater part of the inner concrete floor was cut away from the foundation in order to prevent the former from being unduly influenced by the latter.

2. Results of measurements.

The Mitaka comparison base has been often measured in testing

the Jäderin wires. Figs. 2-5 represent the relation between the length of the base and the temperature as observed in free air. The base

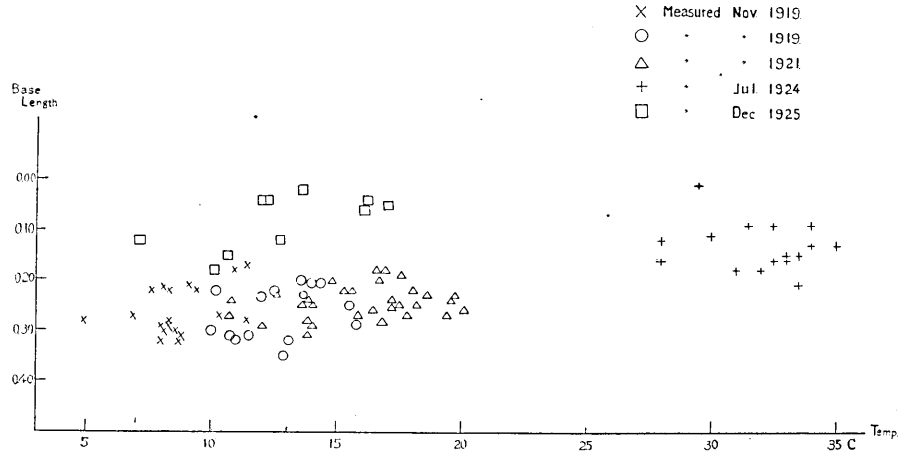


Fig. 2. Relation between air temperature and the length of the 25 m. Comparison Base Line as measured by a Guillaume 5 m. apparatus.

apparatus used was the Guillaume 5 m. Standard Scale, and the method of measurement invariably the same.

The chief points in the Figures to which attention is drawn are following:

a) As results prior to 1923 are distributed almost horizontally, the changes in length due to temperature are not marked. The mean value of the measured length for each year is practically the same.

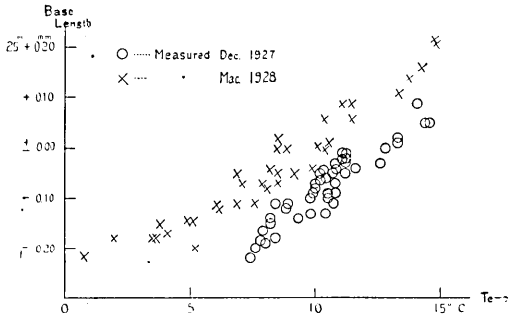


Fig. 3. Relation between air temperature and the length of the 25 m. Comparison Base Line as measured by a Guillaume 5 m. apparatus.

b) In the results for 1924 and 1925, the changes in length with temperature are very small but the mean length during 1924 is elongated as compared with values prior to 1923, while the mean length for 1925 is considerably larger than that for 1924.

c) Since 1927 the length has changed in a remarkable manner with variations of temperature. The length of the base has increased gradually every year. Fig. 8 shows the yearly change in the length of

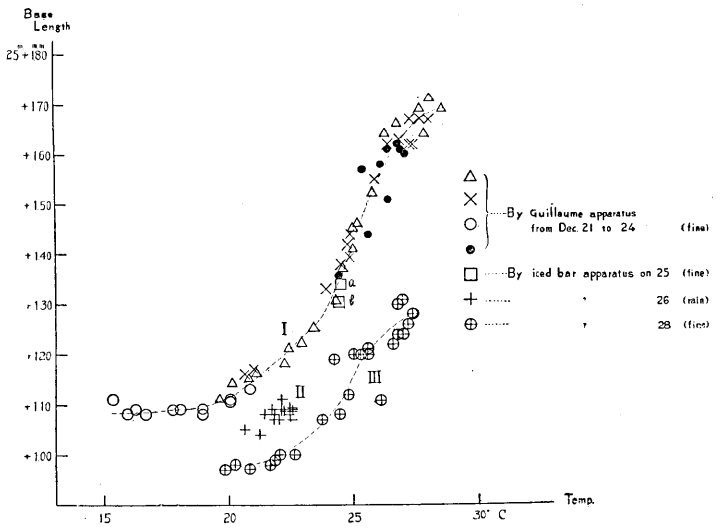


Fig. 4. Relation between air temperature and the length of the 25 m. Base Line as measured by a 5 m. Guillaume apparatus and a 5 m. Invar apparatus.

the base line at 10°C.

Previous to 1925, measuring was done in a tent but since 1927 in a house. It is an interesting fact that the marked changes in the length appeared in measurements that were made in the comparison room.

3. The measurement of September, 1931.

Fig. 4 shows the results of measurements taken in Sept. 1931, at the request of the Earthquake Research Institute. Curve I was obtained by the Guillaume apparatus and curves II and III by a 5 m. Iced Bar. The different symbols on curve I show the different days on which the measurements were taken. The weather during the measurement of I was fair, of II rainy, and of III clear.

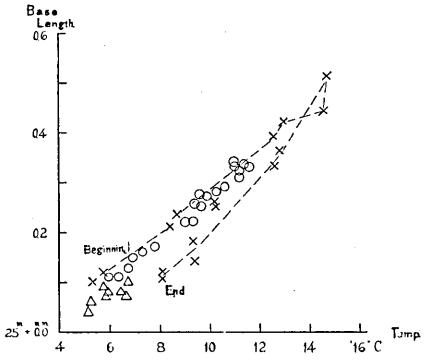


Fig. 5. Relation between air temperature and the Base Line as measured by a 5 m. Guillaume apparatus in March 1932.

The two points marked *a* and *b* in I near 24°·5 were obtained by the Iced Bar the day before measurement of II. The weather was fine

on the days when II and I were measured.

From this Figure 4 it is seen that

i) The changes shown by the Guillaume apparatus are the same every day.

ii) The daily changes shown by the Iced Bar assume a step like order, as shown by *a*, *b*, II and III.

iii) The shapes of curves I and III are similar.

iv) The changes during high and low temperatures are not so marked as those during middle temperatures.

v) The inclinations of I and III are more pronounced than those of curves in Figs. 3 and 5.

4. The measurement of March, 1932.

Figs. 5 and 6 show the measurements made in March 1932; those of the former by the Guillaume apparatus and those of the latter by the Invar 5 m. apparatus, newly made by the Société Genêvoise. The various symbols in the figures represent the different days on which the measurements were taken. The same method of measurement was used with both apparatus.

The chief points of interest in Figs. 5 and 6 are as follows:

i) The length varies with the period of a daily cycle of changes and the sense of the cycle, whether clockwise or counter-clockwise, is not always fixed.

ii) The results obtained by both apparatus are practically the same.

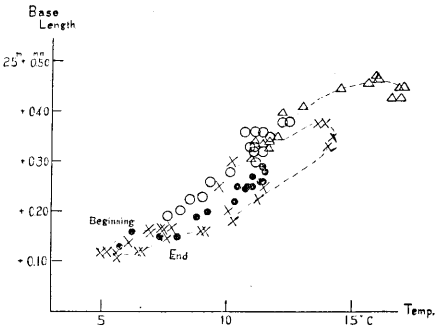


Fig. 6. Relation between air temperature and the length of the 25 m. Base Line as measured by an Invar apparatus in March 1932.

5. Variations in the length of the comparison base.

i) The variations in the length of the base began with the completion of the comparison house. This daily variation in sympathy with the air temperature resembles the variation in the temperature of the ground surface relatively to the air temperature. Fig. 7 shows the temperature variations of the ground surface with reference to the air temperature.

The maximum elongations of the base through temperature since 1927 are as follows:

| | | |
|---|---|---|
| 1927 | $1{\cdot}8\times10^{-6}$ | Guillaume apparatus |
| 1928 | 1·7 | ,, ,, |
| 1929 | 0·8 | ,, ,, |
| 1931 | 3·8 | ,, ,, |
| ,, | 2·8 | Iced Bar |
| 1932 | 1·7 | Guillaume apparatus |
| ,, | 1.8 | Invar 5 m. apparatus |

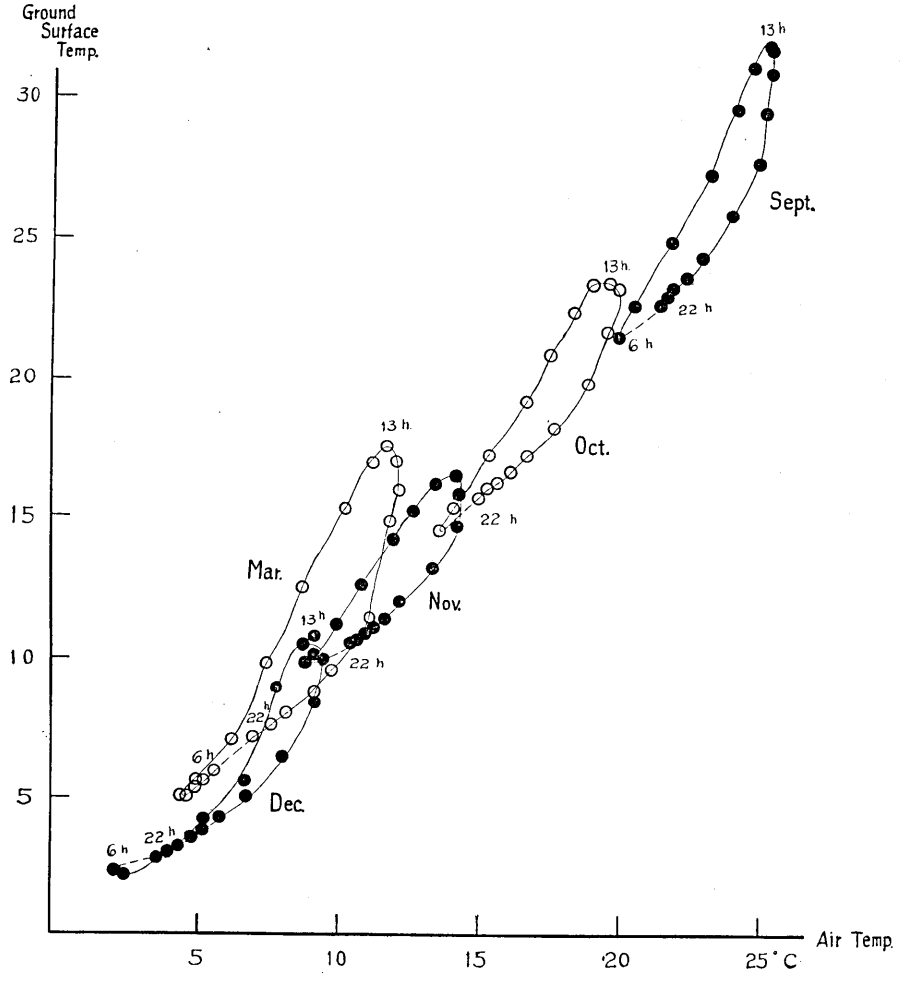


Fig. 7. Relation between air temperature and ground surface temperature.
(Monthly average during 1919.)

These rates of elongation closely resemble the coefficient of expansion of concrete, which is $2{\cdot}5-4{\cdot}0\times10^{-6}$. The absence of any particular difference in the results from the Guillaume apparatus, the Iced Bar, and the Invar apparatus are significant. From these considerations the chief cause of variation in the measured length seems to lie not in the measuring apparatus, but in the expansion and contraction of the concrete floor of the comparison house.

ii) The step-like changes in the measured length may be due to the following two causes:

a) Cooling of the concrete through water from melting ice used for the Iced Bar and from rain.

b) In the daily swings of the foundation of the base terminals due to expansion and contraction, the foundation does not in a day's cycle of swings return always to the original position it held before the begining of the movement.

iii) The secular variations in the base length may be owing to the following causes:

a) Movements of the earth's crust.

b) Peculiarities in the construction of the comparison house.

Of the above two possible causes, it is inconceivable that (a) is responsible for the pronounced changes in length observed since 1927. The major part of the secular variation seems to be due to cause (b). Previous to 1925, excepting the slight changes in 1923–4 caused probably by the great earthquake of 1923, the changes

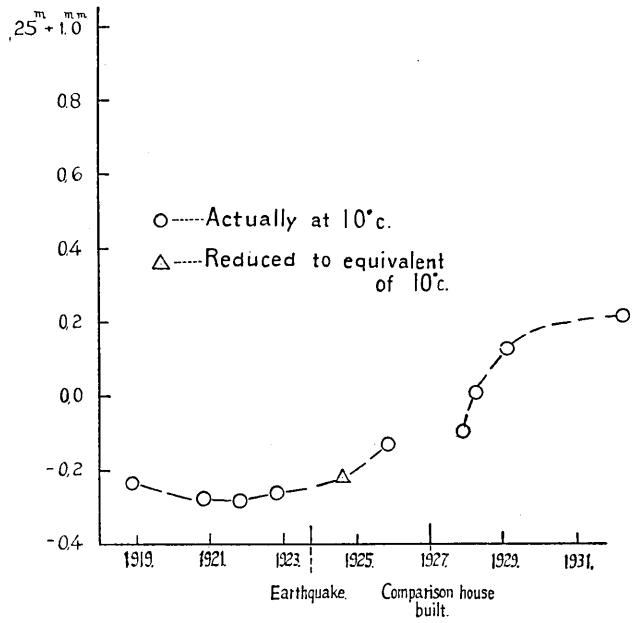


Fig. 8. Changes in the length of the 25 m. Comparison Base Line at 10°C.

were insignificant. The chief cause of (b) is probably changes in the positions of the terminals due to expansion and contraction of the concrete floor.

As shown in Fig. 8, the results of 1931 are very different from those of other years. They show the seasonal variations of the base. The cause of these variations may also be the cause of changes in the position of the terminals as already mentioned.

6. Expansion and contraction of the ground.

The marked changes in the base length through temperature effects since 1927 have already been referred to. As to the changes before 1927, although very slight they are nevertheless noticeable. The rates of expansion due to temperature as obtained from the Figures are as follows :

| | |
|---|---|
| 1919 | $0{\cdot}31\times10^{-6}$ |
| 1920 | 0·24 ,, |
| 1921 | 0·27 ,, |
| 1922 | 0·31 ,, |
| 1924 | 0·46 ,, |
| 1925 | 0·32 ,, |

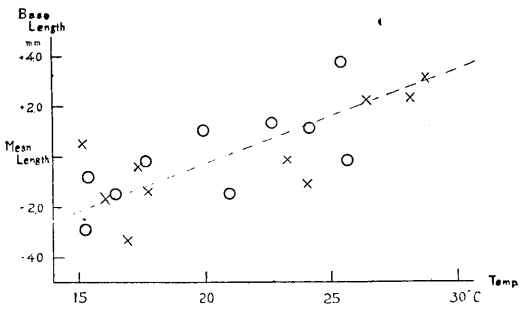


Fig. 9. Relation between the air temperature and the length of the Otani Base Line.

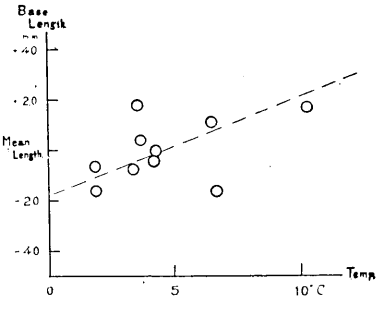


Fig. 10. Relation between the air temperature and the length of the Aibano Base Line.

Figs. 9–11 show the lengths of the geodetic base line relatively to the temperature at the time they were measured. The rates of expansion obtained from these figures are

| | |
|---|---|
| Ootani base | $0{\cdot}15\times10^{-6}$ |
| Aibano base | 0·13 ,, |
| 100 m. base (ES) at Mitaka | 0·46 ,, |

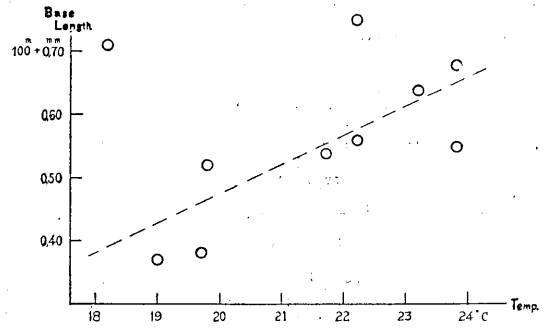


Fig. 11. Relation between the air temperature and the length of the Mitaka 100 m. Rhombic Base Line.

As these values coincide tolerably well with the values of the comparison base, they may be taken as the expansion coefficients of the ground.

The expansion and contraction of the concrete floors being considered the chief cause of the changes in length of the comparison base as already mentioned, two 25 m. base lines were set up on July 18/9, one in front and the other back of the comparison house on the concrete floors outside of the house, and measured on July 29/30. Comparing these results as shown in Fig. 12 with others obtained since 1927, the inevitable conclusion is that the changes in the length of the base line were caused by the expansion and contraction of the concrete floors.

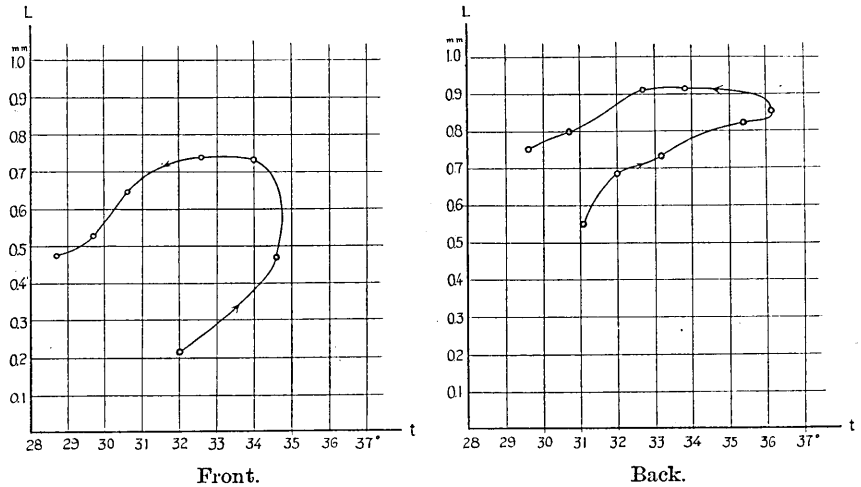


Fig. 12. Changes in the length of the 25 m. concrete floor.

# 51. 三鷹村二十五米比較基線長の變化について

陸地測量部 武藤勝彦
陸地測量部 篠邦彦

三鷹村25米比較基線長が溫度によつてかなり著しい變化をすることは大分前から知られて居た。この變化が何に基因するかをしらべた結果その大部分の原因は比較室のコンクリート床の溫度による伸縮にあることを知つた。又溫度による比較室建設前の微弱な變化其他の野外基線長の變化から土地の溫度に對する伸長率を求めた。尙最後にコンクリート床の溫度による伸縮をたしかめるため新たにコンクリート床自身の上に直接25米の基線をとつて測定した結果をつけ加へてある。