MEASUREMENT BACK UP SYSTEM FOR SUBSTATION EQUIPMENT BASE PLATES

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ABSTRUCT

To enable the construction of substation plant to be carried out in a streamlined way, a System has been built up which backs up the measurement of the position of base plates for installing the equipment.

This system is capable of; (1) reading the design value of base position from CAD data automatically, (2) making sure of discrepancy between design value and measured value immediately during measurement and (3) outputting the measurement results automatically in a spread sheet form.

This system reads the design value automatically by fetching CAD data of DXF type, recognizing a plate automatically by utilizing such shape feature as a square of the base plate, recognizing a dimensional auxiliary line connected with the base plate and further, recognizing a dimensional line connected with the dimensional auxiliary line and a designed dimension drawn on the dimensional line.

A prospect has been obtained that by making use of this system, reduction in the time of measurement work of base plate position and improvement in reliability can be attained. Form now on, it is scheduled to examine an automatic measurement system by the image sensing.

1. Introduction

Such equipment as a switch-gear or transformer of the substation plant is installed on H-steel-made base plate embedded into concrete. A work which measures the base plates placed position and makes sure that discrepancy with the design value is less than an allowable value becomes important for securing the installation accuracy of equipment.

Conventionally, Y-level, steel measure, piano wire, etc. have been used for the measurement work of this base plate position and at present, a three-dimensional measuring instrument (total station) is used for streamlining the execution of work.

However, the number of base plates is about as much as 200 pieces per work site and an error which takes a wrong measures plate is liable to occur. Also, the work which reads the design value of base position from the plan and the work which puts the measurement results in order have been done by hand and it has taken much

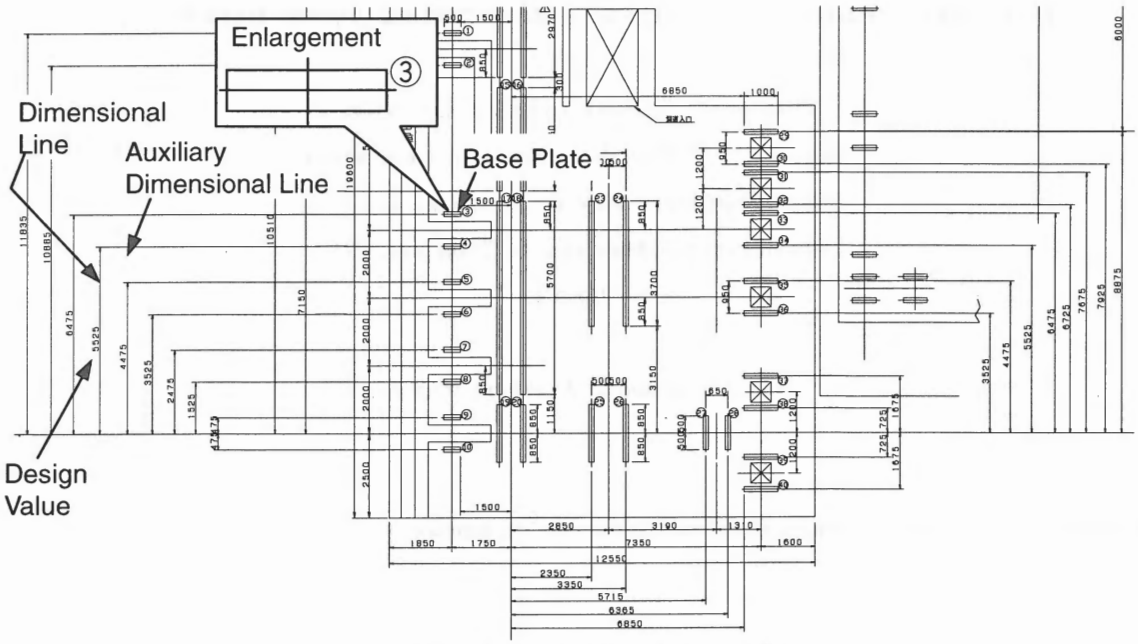

Figure 1 CAD Plan of Base Plate

time and labor for the work.

For the above reasons, we have embarked on the building-up of a measurement work backup system of base plate position which is capable of reading the design value of the base position automatically, making sure of discrepancy between measured value and design value right off while the measurement of base position is going on and outputting the measurement results automatically in a spread sheet form.

2. Measuring procedure and problems

The order of the measurement work of base plate position is such that the design value of the base position is read from the plan and after confirming the measured value and design value by comparing with each other with measurement of the base position, a document is prepared. Figure 1 shows CAD plan of the base plate. The number of base plates reaches as much as 200 pieces per work site with 20 to 40 pieces of the base set within a range of 10 square meters. The plan has been made into CAD; however the work reading the design value from the plan is done by hand and for all bases, the worker reads the design value and puts the value on record. For the measurement work of base position, the total station type three dimensional measuring instrument has been employed which measures a distance and vertical and horizontal angle to obtain a three dimensional coordinate value. Figure 2 shows the measurement condition of base plate with the use of the total station. The measurement results are recorded in a controller and after end of the measurement, the measured values are printed out all together.

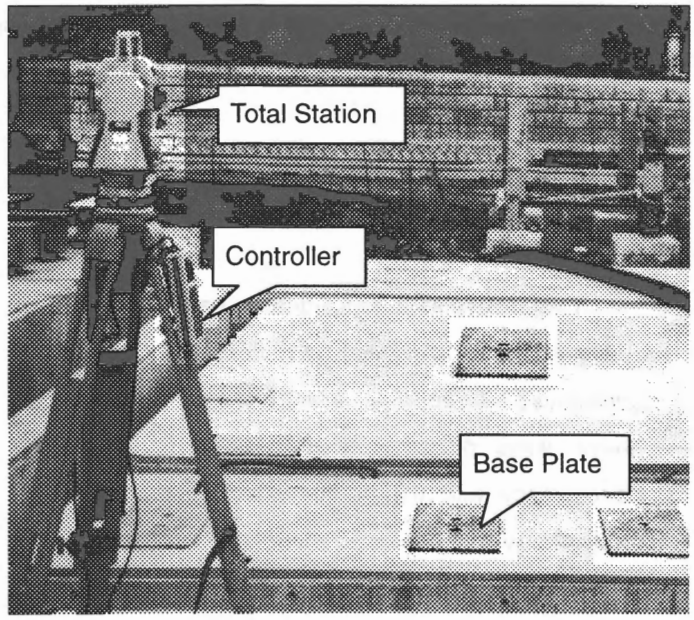

Figure 2 Measurement Condition of Base Plate

The measurement accuracy of the total station is ±1mm which is an enough accuracy relative to an allowable accuracy of the base placed position which is less than ±2mm.

However, because of a plural bases having the same shape being measured, there is a great possibility of an error occurring, for example, the same base is measured twice or a base not measured yet exists.

Also, since a discrepancy is estimated by comparing the measured value with the design value after end of the measurement, occurrence of error in measurement cannot be grasped immediately. Further, because of a document compiling work being dome by hand, it takes much time and labor and an error in entry is prone to come about. Therefore, it has been decided to build up a system capable of comparing the measured value of the base position with the design value during measurement with the reading of the base design value and preparing of document automated.

3. Built-up System

3.1 System Configuration

Figure 3 shows the system configuration. The system substantially comprises; personal computer, and printer installed in the office and further, total station and controller used at the site. Consideration has been given so as to enable reading the design value and outputting the data of document through the personal computer in the office, but not increasing the machines and materials used in the field work.

For transmitting the design value and measurement data between the personal computer in the office and the total station at the site, the controller of total station is used and the data are sent and received through a serial interface.

3.2 Automatic Reading of Design Value

The types of figures drawn in the plan are classified into a square, straight line and letters and among them, the straight line has such an attribute as a solid line or a dimensional line. In the plan, the base plate is drawn by a square and the design value, as a letter. A figure linking both is a dimensional line. It has been thought that by making full use of the linking relation of this figure, the design value can be read by extraction the base plate. Figure 4 shows an extraction flow of the base plate. First, in order to extract the base plate, the squares are taken out of the plan, from which the following are excluded : a square adjoining to 4 corners of the plan (column of entry of DWG. No. and designation of

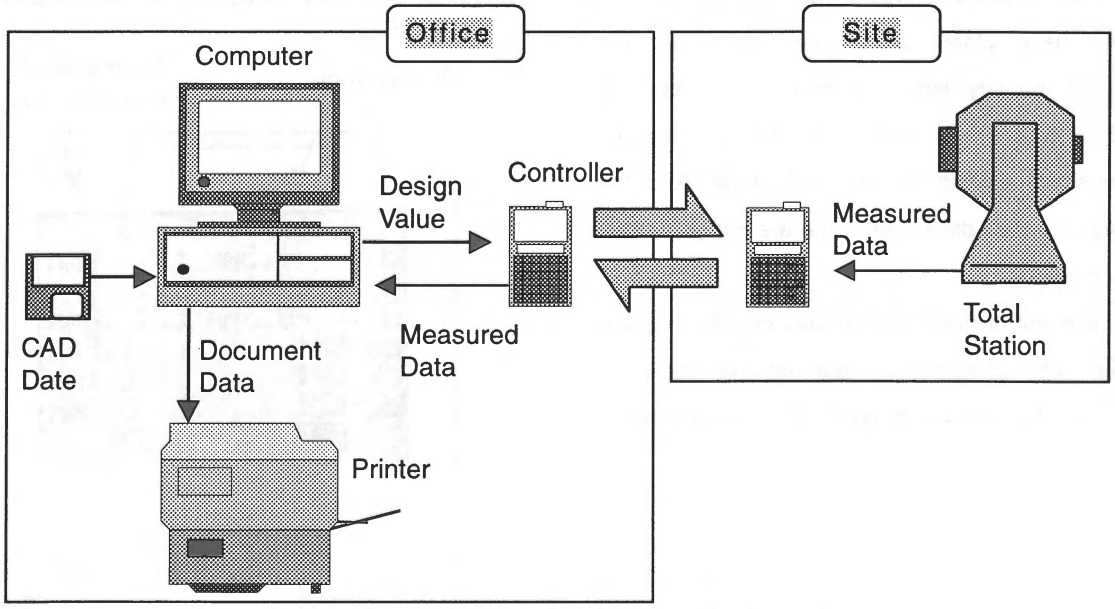

Figure 3 System Configuration

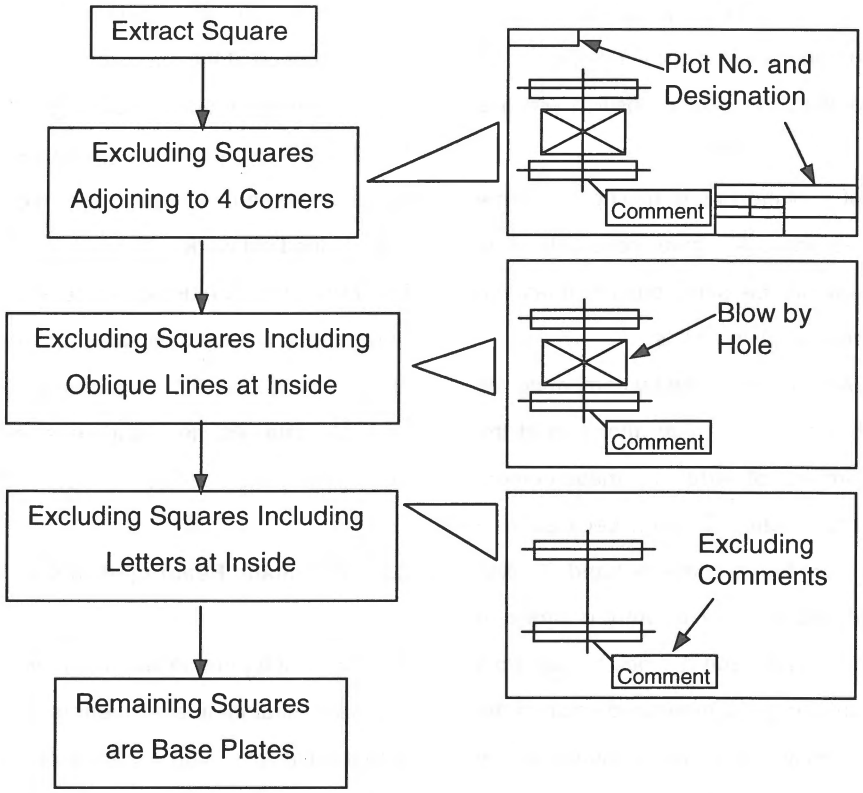

Figure 4 Extraction Flow of Base Plates

drawing), a square including an oblique line at inside (blow by hole) and a square including letters at inside (comment). And, algorithm has been employed which judges that the remaining square is the base plate. Also, identification is made every base plate by extracting the encircled numbers put nearby the base. The encircled numbers put nearby the base denote the numbers used for identifying the base plates and these are always entered at a time of preparing the plan.

After the base plates have been extracted, the dimensional auxiliary lines led from each base are pursued for extracting a dimensional line crossing with the dimensional auxiliary line at a right angle. And, the letters drawn on the dimensional line are recognized as the design value.

The employment of this algorithm has enabled reading the design value of each base automatically merely by designating CAD data file of DXF (Drawing eXchange File) type.

3.3 Field Measurement

The design position data read every base are transferred to the controller of total station through the serial interface. In the controller screen while the measuring work is going on, a discrepancy between the design value and measured value of the has position is displayed. Figure 5 shows the controller display. Also, by setting an allowable value of the discrepancy, it is

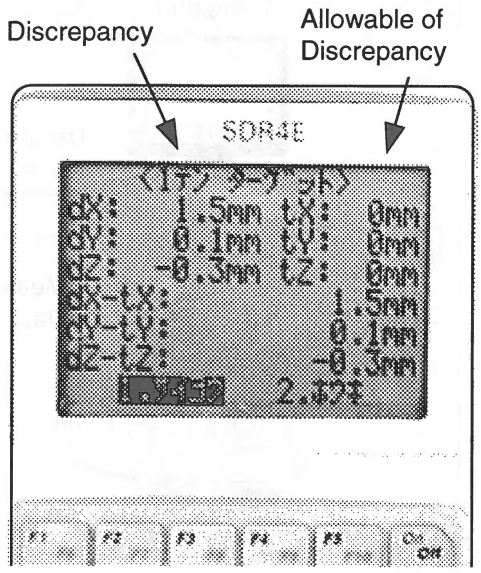

Figure 5 Controller Display

Table 1 Output Example

Time	Final	Site	ABC	Elevation (mm)	0.0	Judgment	
No.	1234	Equipment	72kGIS	Allowance(X,Y) (mm)	±2.0	Good is	○
		Object	Base	Allowance(Z) (mm)	±2.0	No Good is	※

Base No.	Type	Base Plate Position X (mm)	Y (mm)	Z (mm)	Judgement	Worker Date	Memo
1	Design	-1750.0	11835.0	0.0	○	YOKOYAMA 98/03/18	
	Measure	-1750.0	1184.0	1.0			
	Diff.	0.0	-1.0	1.0			
2	Design	-1750.0	10885.0	0.0	○	YOKOYAMA 98/03/18	
	Measure	-1750.3	10885.0	0.5			
	Diff.	-0.3	0.0	0.5			
3	Design	-1750.0	6475.0	0.0	○	YOKOYAMA 98/03/18	
	Mea			0.0			

possible to display only a case where the discrepancy has exceeded the allowable value and while measuring, it is possible to compare the design value of the base position with the measured value.

3.4 Output of Results

The measurement results recorded in the controller of total station are transferred to the computer through the serial interface.

In the document, the date of measurement, name of site and name of person in charge of measurement are put. And, the measured value and design value, discrepancy between both values can be printed out. Table 1 shows the output example. The document and the measurement data are kept in custody as the records of the execution of work.

4. Confirmation of Effect

The effect secured by the system was confirmed at the site with 50 bases as an object. Table 2 shows a comparison in the work time between this system and conventional system. Comparing a case where the reading of design value and the preparation of document have been done by a hand work, a great reduction of the work time has been accomplished in the case where this system has been applied. In addition to the effect brought about by automating the reading work of the design value or the preparation of document, another effect by which an error in measurement has been decreased successfully is also contributing though the measuring time increases a little by always comparing the measured value with the design value while measurement is under way.

Table 2 Comparing Work Time

(Unit : Hour)

Method / Item	New System (Hour)	Hand Work (Hour)
Reading Design Value	0.02	3
Measurement of Base Plate	4.33	4
Measurement again	0	1
Output Document	0.17	3
Total Time	4.52	11

5. Conclusion

With the object of streamlining the execution of work of substation plant, a system has been built up which backs up the measurement work of the base plate position for installing the equipment . As the result of an error which might occur in the measurement work having been decreased with automation of the work reading the design value of the base position and the work preparing a document based on the measurement results, a prospect has been gained that the work time in the conventional hand work can be reduced greatly.

Since this measurement work is a work in which lots of bases having the same shape are measured repeatedly, it is suitable for automation. After this, it is scheduled to examine an automatic measuring method with image sensing.