ON THE DEVELOPMENT OF A SUITABLE NUMBER CODING SYSTEM FOR POINTS IN A PHOTOGRAMMETRIC BLOCK

A Dissertation
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ADVANCED SURVEY AND PHOTOGRAMMETRY

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CERTIFICATE

Certified that the dissertation entitled " ON THE DEVELOPMENT OF A SUITABLE NUMBER CODING SYSTEM FOR POINTS IN A PHOTOGRAMMETRIC BLOCK " which is being submitted by Sri Ram Saran Srivastava in partial fulfilment for the award of the Degree of Master of Engineering in ADVANCED SURVEY AND PHOTOGRAMMETRY of the Roorkee University, is a record of the student's own work carried out by him under our supervision and guidance. The matter embodied in this dissertation has not been submitted for the award of any other Degree or Diploma.

This is further to certify that Sri Srivastava has worked for a period of about Six months from January 1970 to June, 1970 for preparing the dissertation for the MASTER OF ENGINEERING DEGREE at this University.

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29/6

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ACKNOWLEDGEMENT

The problem of developing a code system for points in a photogrammetric block was set up by Prof. H. L. Oswal during a discussion. I found this problem of irresistable interest and my interest increased as the work progressed. I am thankful to Prof. Oswal and Sri R. C. Badjatia for their guidance at all stages of the work.

The International Air Survey and Training Centre was prompt to share the information they had and I am grateful to Mr. J. Kure for the trouble that he took in answering my queries. The problem was also discussed with a few colleagues in India and the author is grateful to them for sparing their time.

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ABSTRACT

In block triangulation one has to deal with a large volume of experimental data involving hundreds of observation points. Relevant information pertaining to each observation point must also be recorded along with image/model coordinates. A code system for photogrammetric points condenses the information in a small space and is very convenient for reference at all stages of the work, and later.

Almost all organizations who deal with block triangulation use, of necessity, a code system developed by them--selves. These codes are understandably suitable for particular jobs and lack general applicability. In this thesis an attempt has been made to study the problem in generality and to develop code systems found usable by the majority of organizations.

Three code systems have been proposed. The number coding system and alpha-numeric system have been proposed for a block covered with spatial aerial triangulation while the alphabetic coding system is meant for block covered by radial triangulation method. The three code systems developed donot present any difficulty in computer programming.

A national organization has to deal with hundreds of photogrammetric blocks. A code numbering system for photogrammetric block taking as a whole, has also been developed in this thesis. This code system will be found useful in a national organization such as Survey of India, the need of which has been constantly kept in mind.

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CHAPTER 1.

INTRODUCTORY

1.1. Introduction:- The technique of block triangulation for providing supplementary ground control for the purpose of mapping is in common use at the present time. There are basically three approaches, the analogue solution, the analytical method, or a combination of analogue and analytical techniques. The block is essentially made up of a number of strips and each strip in turn contains a number of photograms. In any method of block triangulation, therefore, one has to simultaneously deal with hundreds of photograms each containing a few of observed points. Along with the image or model coordinates of each point, it is necessary to record other important information, for example the strip and photo numbers, and the location and function of the point in the block triangulation scheme.

Block triangulation is a voluminous work involving large personnel at various stages thereof. Main object of point numbers is their unique identification in the block. If care is not taken confusion is bound to be caused at a later time. In addition, the code system would be helpful if, for example

(a) the point is easily located in the block area,

(b) the type of point is immediately apparent

(c) the precision of the point is conveyed

(d) the code number conveys information on various aspects of connected photogrammetric work,

(e) the code number is unique and thus avoids any confusion.

Of necessity, all organisations who deal with block triangulation use a code system in some form. I.T.C.(International training centre at Delft) developed a code system for their hypothetical blocks. Ackerman also used a code system while working on Rhodesian triangulation. Survey of India (S.O.I.) has also developed a code system and it is being used at present. Recently Prof. Oswal[5] developed a code while engaged in the construction of blocks of mathematical photograms. Nevertheless due to lack of adequate published literature on this subject it is difficult to fully account the development and use of code systems for photogrammetric points. It can, however, be said that no serious attempt has yet been made to develop a general code system suitable to majority of organisations. The codes developed in the past were designed for particular projects in hand , and are , therefore, of limited significance.

In this study an attempt has been made to develop a system in general terms such that it can be adopted by the majority organisations for their schemes of block triangulation. This thesis deals with a problem of great general and practical value.

1.2. <u>Definitions and Historical development:</u>

It may not be out of place to give a brief account of the development of codes and ciphers in general. The Latin word codex, from which the word code is derived, means a book, consisting originally of wooden tablets covered with wax and later of sheets of parchment or papyrus. The science concerned with the methods and means employed in secret communication is called Cryptology or Cryptography. The process of converting a plain text message into a cryptogram is called enciphering (or encoding); that of reconverting the cryptogram back into its intelligible form, when done by a proper key, is called deciphering (or decoding).

The basic methods by which the information may be brought out are:

(1) Code system which is a secret language. The language may consist of usual alphabets and numbers or specially designed alphabets and symbols.

(2) Cipher system which uses the ordinary language but specially written.

It may be stated at the outset that an authentic history of cryptology is not available. Moreover, inseperable association of secrecy with such work, has made the job rather difficult. Tallius Tiro used a shorthand language since the time of Romans. Jean Francois, an Egyptian, also worked on the development of ciphers and codes. Aeneas Tacticus (360 to 390 B.C.) wrote the earliest treatise on codes which contains the description of cipher disks. The beginning of modern cryptography can be traced back to Italy. During the first two years of World War I cipher systems were extensively used. By 1917 codes came to be used in most military units.

The application of codes and ciphers in photogrammetry is comparatively new. The full advantage of codes and ciphers lies in the secrecy of communication. In photogrammetry, however, secrecy is not normally essential.

1.3. <u>Aims and objectives of the code system under study.</u>

A code as defined earlier is a secret language developed for specific purpose. Any code system must essentially meet the following three requirements:

(1) It must not be so complicated or require the use of such apparatus that it cannot be handled by the person required to use it in the circumstances in which he is placed. For example a system suitable for diplomatic cables would be useless for a soldier at war.

(2) It must not be so constructed that a single mistake in composition or in transmission make nonsense of the remainder of the text.

(3) It must not be possible to extract more than one meaning from the message.

Only usual alphabets and numerals will be used in the present development of the code system for photogrammetric blocks.

Three separate systems will be proposed; one in which only natural numbers will be used (Number coding system) and in the other alphabets can also be used, along with numerals (Alpha Numeric coding system). Third system will be in which only alphabets will be used (Alphabetic coding system) three coding systems do not differ much in principle and formulation but they very well demonstrate the various ways in which a code can be developed for a photogrammetric block.

In any of the three systems proposed here with the basic idea is to incorporate all the important information and yet maintain the simplicity and applicability of the code.

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CHAPTER 2.

ELEMENTS OF A PHOTOGRAMMETRIC BLOCK

2.1. General:

Important specifications of the photogrammetric block and the block points must be included in the code system. One should know the type of photography, terrain characteristics and the format. The code number of an observation point should bring out all important information pertaining to the point. For example the nature of the point and its function in the triangulation scheme must be understood from the code characteristics.

2.2. Specifications of a photogrammetric block.

The important elements of a photogrammetric block are as follows:

(a) Cartographic region in which the block is located. This specification will help to understand the location of the block in the National Map, and is particularly useful in a National Organization.

(b) Photographic scale of the block. This specification will tell the scale of the block photography, on which depends the precision of planimetric control.

(c) Type of triangulation proposed for the block.

(d) Area covered by the block. This specification will convey whether it is a small block of few photograms or a large one containing hundreds of photograms. The area covered by the block will be given by this specification.

(e) Angle of camera lens from which the block photography has been done.

(f) Format size of the photographic negatives.

(g) Terrain characteristics. This specification will convey the type of terrain whether it is a hilly area or a flat ground.

2.3. Specifications of a photogrammetric points.

The list of specifications of a photogrammetric point is long. Some of the important ones are discussed here briefly. In the code systems to be developed in this thesis all the specifications may not be used. The specifications are as follows:

(a) Strip number. A photogrammetric point may appear in one or two strips as shown in the adjoining figure. This implies that the same point will have different strip numbers as it may be observed in two strips. This ambiguity will be ruled out by allotting a fixed sequence number as will be discussed later in Chapter 4.

6b) Photogram number. The photogrammetric point may appear in 2,3,4,5 or 6 photograms as shown in the Fig. Number of photogram togather with strip number is an information by which the point can be readily located in the photogrammetric block. A point may be allotted different photogram numbers but the uniqueness will be maintained by giving a fixed sequence number to that point.

(c) Type of point. The nature and function of the point in the block triangulation scheme is an important characteristic. For example the point may be a ground control point or a pass point; it may be a pre-pointed or a post-pointed point. If the point is a ground control point its function should be known e.g. whether it will be used for strip adjustment or for final block adjustment. For this purpose the type and precision of the ground control provided by the point should be known. The ground control may be in Planimetry or Altimetry only or both Planimetry or Altimetry control may be provided by the same point. The precision of ground survey may be of the implies that the same point will have different strip numbers as it may be observed in two strips. This ambiguity will be ruled out by allotting a fixed sequence number as will be discussed later in Chapter 4.

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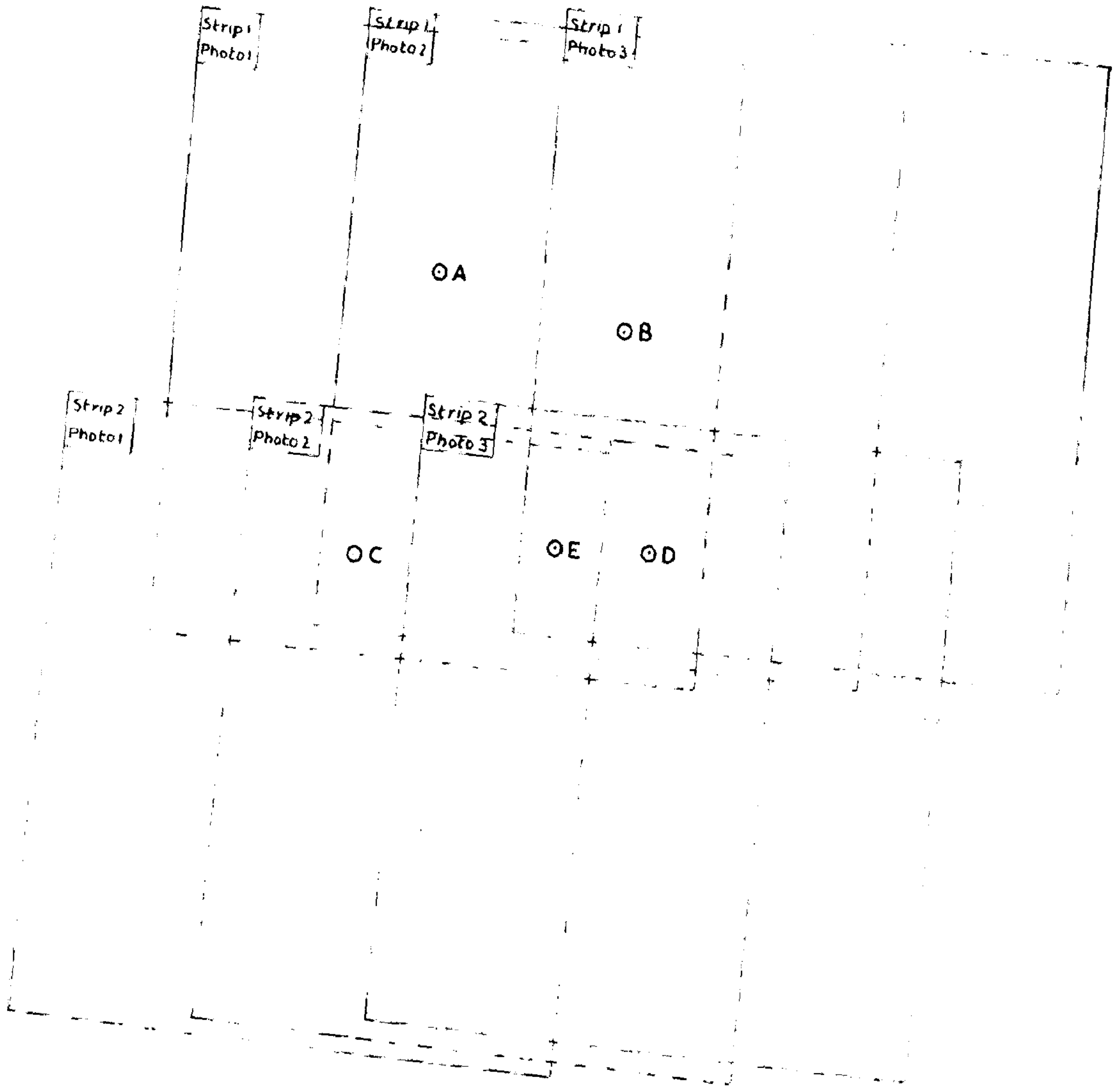
SKETCH SHOWING THE MULTIPLICITY OF PHOTOGRAM POINTS



A APPEARS IN TWO PHOTOGRAMS ORDINARY (LONGITUDINAL LAP)

B APPEARS IN THREE PHOTOGRAMS (LIES IN SUPERLAP OF A STRIP)

C APPEARS IN FOUR PHOTOGRAMS (ORDINARY LATERAL OVERLAP)

D APPEARS IN FIVE PHOTOGRAMS (LIES IN SUPERLAP OF ONE STRIP AI
ORDINARY OVERLAP OF OTHER STRIP

E APPEARS IN SIX PHOTOGRAMS (SUPERLAP OF BOTH STRIPS) first, second, third or fourth order. All such information will be covered by this specification.

(d) Confidence Index number. Exact identification and placement of the floating mark is always a problem for the operator. Great confidence is achieved if the photogrammetric point is well defined e.g. a point on the inter section of two well defined roads or a point on one of the corners of a cultivated field. On the other hand if the definition of the point is somewhat ambiguous such as a point on the bend of a river the floating mark is not always placed on the exact point and this introduces errors. If the point is a prepointed one this difficulty reduces to a minimum. It is, therefore, desirable, at least in research work, that all observational point of a photogrammetric block be assigned identification index number and this number may be referred to assign weights to the final coordinates of the point.

(e) Multiplicity and weight of the point. A photogrammetric point must invariably appear in at least two photograms but by virtue of special positions it may appear in 3,4,5 or 6 photograms. After strip formation and strip adjustment the coordinates of the point are obtained from a number of models or photograms depending upon the method of triangulation. The coordinates obtained from various models/photograms are averaged out and the average value is adopted for further work. By the term multiplicity which is a number (2 to 6) we mean the number of photograms in which the point appears. The information provided by multiplicity number will be convenient while taking average of various values of the coordinates of the same point. This number will also be important in assigning weight to the final coordinates of the point.

(f) Operator's mark and precision of the machine. The volume of observational work is such that a number of operators and machines shall be necessary in order to complete the work in reasonably good time. When a number of operators will simultaneously read and record the point coordinates on various machines, which are available in the organization, the personal human factor combined with prewision of the machine, will be introduced. The various machines that may be used for obtaining image coordinates are Wild A8, Wild A7, Stereo Comparators, Mono Comparators, all of different precision. It is, therefore, desirable, if not entirely necessary, that a record of the operator and the machine used by him may be kept along with other data. For this purpose an alphabet or a number be assigned to each operator and his machine. This alphabet or number should also be a criteria to assign weight to an observation.

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CHAPTER 3.

ELEMENTS OF A CODE SYSTEM AND DEVELOPMENT OF BLOCK NUMBER CODE

3.1. Elements of a code system:

The purpose of any code system is to develop a special arrangement of alphabets, numerals or any other symbols so as to condense the information in a small space. The information so condensed can be read with the help of a key in which the meaning of each alphabet, numeral etc. and the position which it occupies in the code number, has been described. However, the system should be so simple that after a few days of acquaintance with the system, a key should be superfluous.

In any code system the principle of Universal decimal classification (U.D.C.) is followed. The principle can be illustrated by an example. Suppose we want to define the position of a block in the National Map. The first character from the left may be set to indicate the state, the second to indicate the history, the third to indicate 'Tahsil' of the district in which the block is situated. In this way sub-classification of the same basic information may be continued.

The code number may consist of one, two or several characters. For example the first character from the left may stand for strip number, the second for photo number, the third for type of point and so on. Suppose we use only numerals in such a code system the meaning of code number 658 will be that the photogrammetric point lies in fifth photo of sixth strip and it is a point denoted by 8. No key will be required for strip and photo numbers as they are directly given in the first and second character from the left. However, various types of points will be listed and each type will be assigned a number. This forms the key to decode the third character from the left. One can readily see from the key the meaning of number 8 in the third character.

If the number of variables in a list of information are more than ten, it will be necessary to allot two character spaces. In the preceeding example suppose there are 55 types of photogrammetric points then each type can be allotted a number (from 01 to 55) and the information of the type of point will be conveyed in two characters taken togather. These characters will be third and fourth from the left. The meaning of the code number 6532 will be that it is a point in the fifth photo of the sixth strip and the type of point is 32. The meaning of 32 will be decoded from the key.

A code system can be developed with the use of alphabets alone. If we assign the numbers 1,2,3.... etc. to alphabets A,B,C....etc. the strip and photo number can be denoted by alphabets. Similarly each type of point may be allotted an alphabet and this alphabet in the third character from the left will denote the type of point. For example the meaning of the code number FEK will be that the photogrammetric point lies in the fifth photo of the sixth strip and it is a point denoted by the alphabet K which can be decoded with the help of the key.

On these principles one can develop a code system in which alphabets and numerals are used togather.

3.2. Use of alphabets and numerals in the code system

In the preceeding section it has been said that either alphabets or numerals or a combination of both can be used in the development of a code system. The relative advantages and disadvantages of the use of numbers and alphabets will now be discussed.

In case of numbers only ten items can be represented in one character as there are only ten natural numbers e.g. 0,1,2,3,....9. In two characters taken togather hundred items can be represented by the numbers 00,01,02,.. ..11,12,....99. In case of alphabets one can represent 26 items in one character as there are 26 alphabets in the English language. If we take two spaces togather the alphabets can represent 676 (26X26) different characters by virtue of various combinations. The combinations will be as follows:

AA for 01		BA for 27		CA for 53		ZA for 651
AB for 02		BB for 28		CB for 54		ZB for 652
AC for 03	and	BC for 29	and	CC for 55	and so on	ZC for 653
:		:		:		:
AZ for 26		BZ for 52		CZ for 78		ZZ for 676

Use of numbers as compared to alphabets is not advantageous as there are only ten numbers compared to 26 alphabets. However, great advantage in the use of numbers lies in the fact that all of us are conversant with numbers and the system using numbers to specify a number will be easy to decode. In fact no key will be required. For example if we refer the number 28 to denote 28th photo of a strip,it is very simple to understand. On the other hand we will have to refer 'BB' as 28th photo in the alphabetic system. The interpretation or decoding of 'BB' needs the reference of a key.

3.3. Development of a code system for block number

A National organization such as Survey of India has to deal with entire country. If the entire nation is to be covered by photogrammetric blocks the number of blocks to be dealt with, will be quite large. It is, therefore, desirable that a system, to designate blocks, should be developed so that by looking to the block number one knows exactly the place, extent and scale of the photogrammetric block. The observed data of the blocks and the photogram, computer programmes etc. are to be stored in an organized and scientific manner so that exact things can be picked up by all persons. With these ideas in mind a code system is developed, herewith, to designate a photogrammetric block in Indian conditions.

The specifications to designate a block will be as follows:

(a) Cartographic position of the block. The position of the block area in the map of India is an important information. This position can be defined either on the basis of political boundaries or on the basis of latitude and longitude. The political location of the block is not of much use as compared to its location based on an international system. For example, if we say that the block occupies an area in Rajasthan, this is not so informative as compared to the designation that the block covers an area at latitude 32°N and longitude 120°E. Instead of referring the block position to latitudes and longitudes it is desirable to use Indian standard system of numbering topographic sheets.

In the I.A.C. (India and adjacent countries) system numbering extends from 40°N to 4°N and 44°E to 124°E at intervals of 4° in each direction. The entire country is thus divided in 4° squares, which are numbered from top to bottom. When open sea is obtained the numbering is topped in that column. Further each 4°square is subdivided in 16 parts as shown in figure.

A	E	I	M
B	F	J	N
C	G	K	O
D	H	L	P

4° (height) × 4° (width)

The area of a 1°square is roughly 5000 sq.miles. Each 1°square is further subdivided in 16 parts in the I.A.C. system of grid numbering . The 16 parts of 1° square are numbered as shown below:

01	05	09	13
02	06	10	14
03	07	11	15
04	08	12	16

1° (height) × 1° (width)

The area covered by the smallest square e.g. 15'X15' is about 312 square miles. If we specify the central area of the photogrammetric block by the 15'X15' square, the position of the block can be well understood.

(b) Scale of block photography. To specify the scale of the negative, following classification and code digits will be used as shown in Table No.1.

TABLE NO.1

CLASSIFICATION OF PHOTOGRAPHIC SCALE

S.No.	Range of negative scale	Code designation	Remarks
1	Below 1/5000	A	Very large scale photography.
2	⩾1/5000 but < 1/10,000	B	Large scale photography.
3	⩾1/10,000 but < 1/20,000	C	Medium scale photography
4	⩾1/20,000 but < 1/30,000	D	
5	⩾1/30,000 but < 1/50,000	E	Small scale photography
6	⩾1/50,000 but < 1/100,000	F	
7	1/100,000 to 1/200,000	G	

(c) Type of photogrammetric triangulation proposed for the block. Aerial triangulation may be defined as the method of establishing control information (Planimetry and Altimetry) necessary for detailed compilation through geometrical relationships of adjacent photographs. At the present time aerial triangulation can be accomplished by the principle of stereophotogrammetry or the principle of single image photogrammetry. The principle of stereophotogrammetry may be applied to a strip (strip triangulation) or to a number of strips having lateral overlaps (block triangulation).

It is necessary to tell the type of triangulation method proposed for the block. Table No.2 gives a list of various methods of strip and block triangulation. Each category has been assigned a code alphabet to be used later in the development of a block number code.

[Table No. 2 follows]

TABLE NO. 2.

TYPES OF TRIANGULATION METHODS

S.No.	Types of triangulation	Code designation	Remarks
1	Graphical strip triangulation (Arundel's method)	A	
2	Graphical block triangulation	B	
3	Strip triangulation by mechanical methods (slotted templets)	C	Radial triangulation methods.
4	Block triangulation by mechanical methods	D	
5	Analytical strip triangulation Method	E	
6	Analytical radial block triangulation	F	
7	Analog strip triangulation by Aeropolygon method	G	
8	Analog strip triangulation by Aerolevelling method	H	
9	Analytical strip triangulation method	I	Spatial aerial strip triangulation.
10	Semi-analytical strip triangulation method(independent models)	J	
11	Analytical strip triangulation via exterior orientation	K	
12	Analog block triangulation by aeropolygon methods	L	
13	Analog block triangulation by Aerolevelling methods	M	
14	Analytical block triangulation when block is adjusted step by step	N	Spatial aerial block triangulation.
15	Analytical block triangula*ion	O	
16	Semi-analy.block triangulation	P	

(d) Area covered by the block may also be included in the specifications. For this purpose the following classification, based on the surface area covered by the block, is proposed. Code digits have also been allotted in each case.

TABLE NO. 3

CLASSIFICATION FOR SURFACE AREA COVERED BY THE BLOCK

S.No.	Range of area covered by the block in square miles.	Code designation	Remarks
1	Above 5000	L	Large size blocks for small scale mapping.
2	3000 to less than 5000	M	Medium size blocks.
3	1000 to less than 3000	S	Small blocks for large scale mapping.
4	500 to less than 1000	A	Small blocks.
5	250 to less than 500	B	Small blocks.
6	Below 250	C	Very small blocks for special purposes such as engineering projects.

(e) Photographic features. For vertical photography three standard formats e.g. 23X23 cm., 18X18 cm. and 13X13 cm. are in common use in photogrammetry. Rectangular formats and other special formats are also used though sparingly. Also four camera angles namely wide angle, super wide angle, normal angle and narrow angle are most commonly employed. These photographic specifications have been listed in Table No.4.

TABLE NO. 4

CLASSIFICATION OF PHOTOGRAPHIC FEATURES

S.No.	Types of lens	Format, cms.	Code designation
1	Narrow angle lens	23X23	A
2	Narrow angle lens	18X18	E
3	Narrow angle lens	13X13	F
4	Normal angle lens	23X23	B
5	Normal angle lens	18X18	G
6	Normal angle lens	13X13	H
7	Wide angle lens	23X23	C
8	Wide angle lens	18X18	I
9	Wide angle lens	13X13	J
10	Super angle lens	23X23	D
11	Super angle lens	18X18	K
12	Super angle lens	13X13	L

(f) Terrain specifications. In photogrammetry most of the problem become comparatively easy if the terrain is flat or nearly so. For example the achievement of relative orientation of a model is quicker and more perfect if the terrain is flat. It is, therefore, desirable to mention the limits of height variations of a terrain in the code system. Various types of terrain have been classified according to the ranges of height variations with respect to flying height [9].

TABLE NO. 9

TYPE OF TERRAINS

S.No.	Terrain Description	Range of height variations as percent of flying height	Code designation
1	Absolutely flat	0 % to 0 %	A
2	Nearly flat	0 % to less than 2 %	B
3	Moderately rolling	2 % to less than 5 %	C
4	Hilly	5 % to less than 10 %	D
5	Mountaneous	10 % to 25 %	E

The type of terrain can be guessed while doing the preliminary planning for the photogrammetric block. When dealing with blocks of mathematical photograms the five types of terrains, as outlined above, are usually sufficient [9].

(g) <u>CODE FOR BLOCK NUMBER.</u> Incorporating the important specifications as discussed above the block number code can now be formulated. It will be a ten character system excluding two slashes which will be put at appropriate places. In the first five characters the Cartographic position of the block will be specified followed by a slash. After the slash the scale, method of triangulation and the area of the block will be indicated. The camera lens and format specification and the type of terrain will be indicated in the last two characters. The code can be presented in the tabular form as follows:

NUMBER OF CHARACTER FROM THE LEFT									
1 , 2	3	4 , 5	6	6	7	8		9	10
To specify the 4° square in the National map See page 18.	To specify 1° square see page 19	To specify the 15' square. see page 19	A slash sign	Negative scale of the block photography. see Table No.1.	Type of triangulation method. see Table No.2.	Area of the block see Table No.3.	A slash sign	Camera lens and format see Table No.4	Type of terrain see Table No.5

Taking an example of block number 53J15/DEL/BC we mean that the block covers an area around Dehradun city in U.P., the scale of photography is medium (1/20,000 to 1/30,000), and the method of triangulation is analytical. The block covers a large area above 5000 sq.miles. The camera angle was a narrow angle and the format size was 23X23 cm. The block covered an area of moderately rolling terrain.

It was required to attach, herewith, the standard map of India for specifying 4°squares but this cannot be done as the map is said to be a restricted one e.g. a secret document of the Survey of India.

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CHAPTER 4.

DEVELOPMENT OF CODE SYSTEMS FOR PHOTOGRAMMETRIC POINT

4.1. General:

While forming a code for photogrammetric point one is tempted to condense as much information as possible. At the same time the designer of the code likes to maintain the brevity and simplicity of the code. The code must not become unnecessarily lengthy and troublesome to work. With these basic considerations only the important specification of a photogrammetric point,as discussed on pages 8 to 11, will be included in the code systems.

Three separate code systems namely the:

(i) number coding system in which only numerals are used,

(ii) alpha-Numeric coding system in which both alphabets and numerals will be used together,

(iii) alphabetic system in which only alphabet will be used,

will be proposed. In all the three code systems the basic information incorporated in order, is

a) strip number

b) photo number

c) type of point

d sequence number of the point in the index sketch.

The code systems do not differ in principle and outline but they very well demonstrate the basic approach in developing a code system for photogrammetric point.

4.2. <u>The number coding system for photogrammetric points.</u>

The number coding system will consist of nine characters and a decimal point, a total of ten spaces. The arrangement is shown in the tabular form as below:

NUMBER OF CHARACTER FROM THE LEFT					
1, 2	3, 4	5, 6		7, 8, 9	10
Strip number	Photo number	Type of point (see Tables 6 to 14).	decimal point	Sequence number of point in the	

Taking an example of the code number 121772·018 the meaning will be that the point lies in 17th photo of the 12th strip. It is a point of type 72 e.g. a triangulation station of 2nd order precision (see table No.13) and the sequence number of this point in the index sketch is 018 or 18 (appears as 18 in the index sketch, fig.1).

4.2.1. Classification of photogrammetric points for number coding system:

In the fifth and sixth character spaces of the code system already developed the type of points will be indicated by a number of two digits. The principle of classification will be the Universal Decimal Classification (U.D.C. system) System similar to that used for classification of Library Books. The first character will classify the point in main group while the second digit will further indicate the subgroup.

Table No.6 gives the list of main groups in which the photogrammetric point is classified. Each category has been assigned a basic number and a leading symbol. Further subclassification of the main group will be done by the next number. The symbols for each subclassification will be derived from the leading symbol of the main group.

TABLE NO. 6.

CLASSIFICATION OF PHOTOGRAMMETRIC POINTS IN MAIN GROUPS

S.No.	Code Number	Classification of points	Loading symbol.
1	0	Unclassified points such as fiducial marks, principal point nadir point etc.	+
2	1	Middle pass point and also any other extra pass point not covered by serials 3 and 4.	⌒
3	2	Upper pass point	◡
4	3	Lower pass point	⊥◡
5	4	Control points for final adjustment of the block as a whole.	⩚
6	5	Compatible ground control points.	⊡
7	6	Incompatible ground control points.	◺
8	7	Points of planimetry control alone.	△
9	8	Points of level control alone.	⊙
10	9	Points of special importance in a given terrain such as shore line points in an hydrographic survey or points on the demarcation line in a boundary survey.	To be fixed in each individual case.

Detailed classification of photogrammetric points into subgroups is done in table numbers 7 to 14.

TABLE No. 7.

SUB GROUP CLASSIFICATION OF PHOTOGRAMMETRIC POINTS:GENERAL POINTS

S.No.	Code Number	Classification of points	Symbol
1	00	Perspective centre	+
2	01	Upper fiducial mark	⍏
3	02	Lower fiducial mark	⍖
4	03	Fiducial mark on the left	⇷
5	04	Fiducial mark on the right	⇸
6	05	Highest point in the model	♁
7	06	Lowest point in the model	♀
8	07	Model connection points or scale transfer points	×
9	08	Points for relative orientation.	⁜
10	09	Points for absolute orientation.	⁘

TABLE NO. 8

SUBGROUP CLASSIFICATION OF PHOTOGRAMMETRIC POINTS:MIDDLE PASS POINT

S.No.	Code Number	Classification of points	Symbol
1	10	Middle pass point selected in the photo.	⌒
2	11	Middle pass point transferred from left photo.	⌒
3	12	Middle pass point transferred from right photo.	⌒
4	13	Any other extra pass point selected in the photo.	⌓
5	14	A point which is of type 13 but transferred from left photo.	⌓
6	15	A point of type 13 but transferred from right photo.	⌓
7	16	A prepointed point	△
8	17	A point of type 16 but transferred from left photo.	△
9	18	A point of type 16 but transferred from right photo.	△
10	19	Vacant.	

A lower pass point in strip 1 will become an upper pass point in strip 2. Similarly an upper pass point in strip 3 will become a lower pass point in strip 2. Due to these ambiguities a common symbol has been allotted to upper and lower pass points. Further more an upper or lower pass point will be observed in preceeding as well as succeeding photogram in each strip. The subgroup classification of upper and lower pass points is given in Table 9.

TABLE NO. 9.

SUBGROUP CLASSIFICATION OF PHOTOGRAMMETRIC POINTS : UPPER AND LOWER PASS POINTS

S.No.	Code Number	Classification of points	Symbol
1	20	Upper pass point selected in the photogram.	◡
2	21	Upper pass point transferred from left photo.	◡
3	22	Upper pass point transferred from right photo.	◡
4	23	Lower pass point selected in the photogram.	◡
5	24	Lower pass point transferred from left photo.	◡
6	25	Lower pass point transferred from right photo.	◡

[Code numbers 26 to 39 ... are vacant.]

TABLE NO.10

SUBGROUP CLASSIFICATION OF PHOTOGRAMMETRIC POINTS : FINAL BLOCK ADJUSTMENT POINT

S.No.	Code Number	Classification of points	Symbol
1	40	Check points for final adjustment of the block.	⩚

[Code numbers 41 to 49....are vacant.]

TABLE NO. 11

SUBGROUP CLASSIFICATION OF PHOTOGRAMMETRIC POINTS : COMPATIBLE† GROUND CONTROL POINTS

S.No.	Code Number	Classification of points	Symbol
1	50	Unclassified such as geodimeter point, point from radar triangulation.	⊡
2	51	Point of first order precision.	⊠
3	52	Point of second order precision	⧈
4	53	Point of third order precision.	▥
5	54	Point of fourth order precision	⊟
6	55	Exposure station(horizontal position and elevation)	⌶
7	56	Point of known latitude, longitude and elevation.	⊞

[code numbers 57 to 59... are vacant]

† Equally well determined horizontal position and elevation.

TABLE NO.12

SUBGROUP CLASSIFICATION OF PHOTOGRAMMETRIC POINTS : INCOMPATIBLE GROUND CONTROL POINTS

S.No	Code Number	Classification of points	Symbol
1	60	Unclassified points where geodimeter, A.P.R.,etc. is used.	⊿
2	61	Planimetry of 1st order but level not of first order.	⊿
3	62	Planimetry of second order but level of 1st order.	⊿
4	63	Planimetry of 3rd order but level of 2nd order.	⊿
5	64	Planimetry of 4th order but level of higher precision.	⊿
6	65	Exposure station where horizontal and elevational positions are not equally well determined	⊿
7	66	Point of known latitude, longitude and elevation(uncompatible)	⊿
8	67	Planimetry of second order but level from barometer.	⊿
9	68	Planimetry of 3rd order but levelling from barometer.	⊿
10	69	Vacant.	

TABLE NO.13

SUBGROUP CLASSIFICATION OF PHOTOGRAMMETRIC POINTS : POINTS OF PLANIMETRY ALONE

S.No.	Code Number	Classification of points	Symbol
1	70	Unclassified points	△
2	71	Triangulation stations of first order precision.	△
3	72	Triangulation stations of 2nd order precision.	△
4	73	Triangulation stations of 3rd order precision.	△
5	74	Map position, plane table fixings(points of 4th order position).	△
6	75	Exposure station with known horizontal position only.	⅄
7	76	Point of known latitude, longitude only.	△
8	77	Trilateration points.	△
9	78	Vacant.	
10	79	Vacant.	

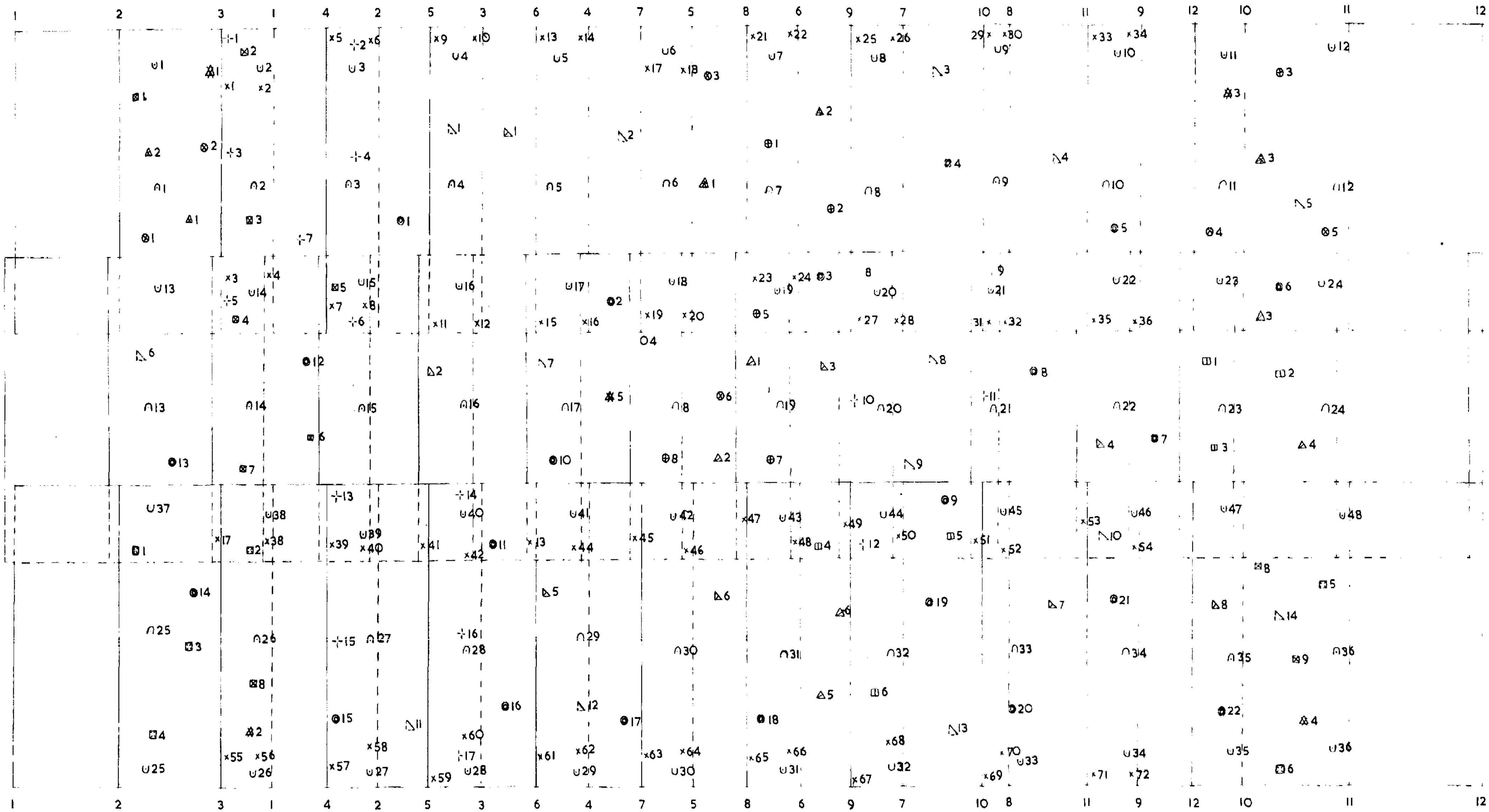
TABLE NO.14

SUBGROUP CLASSIFICATION OF PHOTOGRAMMETRIC POINTS : POINTS OF LEVEL ALONE

S.No.	Code Number	Classification of points	Symbol
1	80	Unclassified points.	⊙
2	81	Bench marks of 1st order precision.	⊗
3	82	Points of 2nd order precision (spirit levelling)	⊗
4	83	Points of 3rd order precision (Trigonometrical levelling)	⦶
5	84	Points of 4th order precision (A.P.R., Barometer, clinometer)	⊕
6	85	Exposure station with known elevation only.	⌖
7	86	A.P.R. Points(Air borne profile recorder).	◎
8	87	Levels obtained by interpolation of contours of existing maps.	○
9	88	Vacant.	
10	89	Vacant.	

ILLUSTRATIVE INDEX SKETCH OF A BLOCK

BLOCK NO.-12 B10 / CDL / BC



NOTE : — THE NUMBERS 1 2 3 ETC AT THE TOP AND BOTTOM OF STRIP 1 AND INDICATE THE EXTENT OF PHOTO NUMBERS RESPECTIVELY

FIG. 1

4.2.2. <u>Procedure for working with number coding system</u>:

Before starting observations for block triangulation it is essential to have a preliminary but thorough study of the entire terrain. A pocket or mirror stereoscope is generally used. An index sketch is prepared showing the strips and all the principal points of the block. A scheme for observation points in each model/image is then prepared to avoid any confusion and omission at the observational stage. On this index sketch are shown all the observation points. A typical index sketch is seen in figure 1. Three strips of the block have been shown, the observation points are shown with their symbols and sequence numbers. Each category of points is numbered separately with its symbol. For example all the points for final adjustment of the block (type 40, see table no.10) will be shown as ⩓1, ⩓2, ⩓3, etc. If, there are six such points the last point will appear as ⩓6, in the index sketch. Similarly all level control points obtained by A.P.B. (type 06, see table no.14) will be shown as ◎1, ◎2, ◎3,..... etc., and if there are 120 such points the last point will appear as ◎ 120.

It may be noted here that all types of points have been assigned unique code numbers and symbols except the upper and lower pass points. The upper and lower pass points have been assigned the same symbol e.g. ◡ because an upper pass point in one strip may become a lower pass point of the preceeding strip. Similarly a lower pass point in one strip may become an upper pass point in the succeeding strip. Furthermore a pass point is observed three times in each strip as given below.

(i) The photogram in which the pass point has been initially selected.

(ii) Immediately preceeding photogram i.e. the pass point transferred from right photo.

(iii) Immediately succeeding photogram i.e. a pass point transferred from left photo.

To illustrate clearly let us take an example of fourth photo in second strip (see fig.1) in which the upper pass point ◡16 has been selected. This point serves as lower pass point in the fourth photo of first strip and will thus be observed six times, three times in strip 1 and three times in strip 2. These six observations of the same point will be codded as :

010325.016 010423.016 010524.016	in the first strip and
020322.016 020420.016 020521.016	in the second strip.

After absolute orientation and strip adjustment the coordinates of the point ◡16 will be obtained in four models i.e. four times. An average of these four values is then taken and the six modes of the point may be reduced to a single value 020420.016.

Similarly a middle pass point is observed three times and its coordinates are obtained from two models. An average value obtained from the two models is adopted and the three modes of the pass point may be reduced to a single value.

4.3. <u>The alpha-numeric coding system for photogrammetric points:</u>

In this system alphabets will also be used with numerals. The advantages of alphabets and numerals will be combined in this system. It will be a five character system as shown in tabular form :

NUMBER OF CODE CHARACTER FROM THE LEFT

1	2	3	4	5
Strip Number [see P-15]	Photo Number [see P-15]	Type of point [see Table 12.]	Number of point in the index sketch [see fig.1]	

Strip number is indicated in the first character from the left by an alphabet. A, B, C, ...Z. will stand for numbers 1, 2, 3 ...26. respectively.

The photo number will be indicated by an alphabet in the second character. The alphabets A, B, C, etc. will have the same meaning as above.

In the fourth and fifth character from the left the sequence number of the point as it appears in the index sketch will be given.

In alpha-numeric system various types of points will be classified in 26 categories so that one alphabet

TABLE NO.12

CLASSIFICATION OF PHOTOGRAMMETRIC POINTS FOR ALPHA-NUMERIC SYSTEM

S.No.	Code letter	Classification of point	Symbol
1	A	Upper and lower fiducial marks	‡
2	B	Fiducial marks on the left/right	⇹
3	C	Highest point in the model	♁
4	D	Lowest point in the model.	♀
5	E	Points for relative orientation	+
6	F	Points for absolute orientation	⁘
7	G	Model connection or scale transfer points.	×
8	H	Middle pass point.	∩
9	I	Upper pass point	∪
10	J	Lower pass point.	∪
11	K	Check points for final adjustment of the block.	⩕
12	L	Compatible ground control points 1st order.	⊠
13	M	Compatible ground control points 2nd order.	⊡
14	N	Compatible ground control points 3rd order.	◺
15	O	Incompatible ground control points	⊟
16	P	Points of planimetry control alone 1st order	▲
17	Q	Points of planimetry control alone 2nd order	⧋
18	R	Points of planimetry control alone 3rd order.	△
19	S	Points of level control alone 1st order	⊗
20	T	Points of level control alone 2nd order	⊗
21	U	Points of level control alone 3rd order	⦶
22	V	Astronomically determined positions	✳
23	W	A.R.P. and Barometer level control.	⊚

[Alphabets X,Y,Z are left vacant to incorporate spl.features of a given terrain. Symbols to be fixed in each case.]

To illustrate the code clearly let us take an example of code number JNK08. The meaning will be that the point lies in 14th photo of tenth strip. It is a ground control point for final adjustment of the block as denoted by letter K in Table 12. This point will appear as 8 in the index sketch.

4.3.1. Limitations of the alpha-numeric coding system.

It may be noted that this system is meant for comparatively smaller blocks containing at the maximum of 100 photograms. The strip number and photogram number can not exceed the number 26 (or the alphabet Z), while the index no. of a point is limited to 99 as only two digit spaces have been allotted for index number. If we select one new middle pass point in each photogram then a block of 100 photograms is possible in this system.

4.4. The alphabetic coding system(for radial triangulation).

In this code system only alphabets will be used.

The main features are essentially the same as in number coding system or in alpha-numeric system, but it has been framed exclusively for analytical radial triangulation. It will be found very useful in analytical methods given by Mout, Hallert, Wolf and Turpin.

It will be a five character system as tabulated below:

Number of code digit from the left				
1	2	3	4	5
Strip No. [see P-15]	Photo No. [see P-15]	Type of Point [see Table 13]	No. of point in the index sketch. [see Page 16]	

To illustrate the operation of the code consider an example of code number AKCAN. The meaning is that the photogrammetric point coded as above lies in the eleventh photo of the 1st strip. It is an upper pass point transfe-rred from the right photo (type C, Table 13) and the number of the point in the index sketch is 14. It appears as 14 in the index sketch (see fig.1).

The classification of points for this system is shown in Table 13.

TABLE No.19.

CLASSIFICATION OF POINTS FOR ALPHABETIC CODING SYSTEM

S.No.	Code letter	Classification of points	Symbol
1	A	Upper pass point transferred from left photo.	◡
2	B	Upper pass point initially selected in the photo.	◡
3	C	Upper pass point transferred from right photo.	◡
4	D	Middle pass point transferred from left photo.	◠
5	E	Middle pass point initially selected in the photo.	◠
6	F	Middle pass point transferred from right photo.	◠
7	G	Lower pass point transferred from left photo.	◡
8	H	Lower pass point initially selected.	◡
9	I	Lower pass point transferred from right photo.	◡
10	J	Principal point transferred from right photo.	⇷
11	K	Principal point of the photogram	+
12	L	Principal point transferred from right photo.	⇸
13	M	Nadir point of the photogram.	⋈
14	O	Iso centre of the photogram	⌶
15	P	Upper and lower fiducial marks.	⍏
16	Q	Fiducial marks on the left and right.	⇞
17	R	Ground control point of known planimetry 1st order precision.	⊠
18	S	Ground control point of known planimetry 2nd order precision.	⧅
19	T	Ground control point of known planimetry 3rd order precision.	◫
20	U	Ground control point of known planimetry 4th order precision.	⊟
21	V	Connection points (Resection points)	x
22	W	Points for final adjustment of the block.	⩝

[Alphabets X,Y,Z are left vacant to incorporate special features of a given terrain. Symbols to be fixed in each case.]

4.4.1. <u>Limitations of the alphabetic coding system.</u>

This code system is applicable to fairly large blocks, as there can be 26 photograms, 26 strips and 625 sequence numbers that can be allotted to a point of any class. The system is therefore workable upto a block of say 600 photograms, the only limitation is that the number of photograms in any strip must not exceed 26, as only one has been provided to indicate the photo number.

In alphabetic system also (as in Number Coding System) same symbol has been assigned to upper and lower pass points. As indicated in Table 13 there will be three ways in which a pass point will be observed. Consider an example of fourth photo in strip no.2 (see fig.1) in which the upper pass point $\dot{\cup}$16 has been selected. This point serves as lower pass point in the fourth photo of strip no.1. This point will thus be observed six times, thrice in strip no.1 and thrice in strip no.2. These six observations of the same point will be coded as:

ACAAN ADDAN AECAN	} in strip no.1 and

BCGAN]
BDHAN] in strip no.2.
BEIAN]

After absolute orientation and strip adjustment the coordinates of the point ◡16 will be obtained in four models or eight photograms according to the method used. An average of these values is then taken and the six modes of the point may be reduced to a single value ADBAN.

The middle pass points are observed thrice and may be similarly dealt.

-:-

CHAPTER 5.

COMPUTER PROGRAMMING AND THE CODE SYSTEMS

5.1. General:

In analytical block triangulation an electronic computer is indispensible. The image or model coordinates of each observation point are first measured and the observed data is then fed in the memory of the computer, along with the necessary programme. When a coding system is used in the block triangulation scheme it is necessary that the code numbers should also be punched along with final ground coordinates of each point. The computer programming does not present any difficulty while working with a code system.

5.2 Computer programme and Number coding system:

In number coding system there are four values associated with each observation point. For example the data will be as given below:

Code Number	X-coordinate	Y-coordinate	Z-coordinate
012462.007	1468.582	3875.016	78.67

- -

This can be programmed as follows:

```
20  FORMAT  (I4,F6.3,17X3F15.3)
        READ 20, (N(I),C(I),XM(I),YM(I),ZM(I),I=1,M)
```

Here the code number contains 9 digits excluding the decimal point and normally an electronic computer works with 8 digits only. Hence the code number is specified in two variables N(I),C(I) put together. XM,YM,ZM denote the model coordinates of each point.

Similarly when the final ground coordinates have been computed the results can be punched as:

```
PUNCH 20,(N(I),C(I),XG(I),YG(I),ZG(I),I=1,M)
```

M denotes the number of points in each model and XG,YG,ZG the final ground coordinates.

5.3 Computer programme and Alpha-Numeric system:

In the Alpha-numeric system the observed data will be of the following form:

Code Number	X-coordinate	Y-coordinate	Z-coordinate
JNK03DC	1402.017	1624.550	38.72

The programme can be made with the following format:

```
20  FORMAT (A3,I2, A2, 20X 3F15.3)
        READ 20,(A(I),N(I),D(I),XM(I),YM(I),ZM(I),I=1,M)
```

The code number has been specified in three variables namely A(I),N(I) and D(I), put together. When the final ground coordinates have been computed the results can be obtained as:

```
PUNCH 20, (A(I),N(I),D(I),XG(I),YG(I),ZG(I),I=1,N)
```

5.4. <u>Computer programme and Alphabetic system:</u>

In the Alphabetic system the observed data will be in the following form:

Code Number	X-coordinate	Y-coordinate	Z-coordinate
CABDF	147.02	165.16	37.25

The format specification in this case will be as:

```
20  FORMAT (A5,2X,3F15.3)
    READ 20,(A(I),XM(I),YM(I),ZM(I),I=1,N)
```

The results will be punched with the following statement :

```
PUNCH 20, (A(I),XG(I),YG(I),ZG(I),I=1,N)
```

The above examples show clearly that computer programming does not present any difficulty while working

CHAPTER 6.

CONCLUSIONS:

6.1. Utility of the proposed code systems:

Four code systems have been proposed in this thesis, one for specifying the block and the remaining three for photogrammetric points. The code for block specification will find use in a national organisation such as the Survey of India, where hundreds of blocks are dealt with. In such a voluminous work the block number will clearly convey all the necessary information of the block. The block numbers will further help in keeping or storing the recorded data, the concerned photograms, computer programs, etc. in a systematic and scientific manner.

The three code systems for photogrammetric points in a block are also applicable for strip triangulation. In strip triangulation as there is only one strip the first specification of strip number may be deleted from the proposed

The code number has been specified in three variables namely A(I),N(I) and D(I), put together. When the final ground coordinates have been computed the results can be obtained as:

```
PUNCH 20, (A(I),N(I),B(I),XG(I),YG(I),ZG(I),I=1,N)
```

5.4. <u>Computer programme and Alphabetic system:</u>

In the Alphabetic system the observed data will be in the following form:

Code Number	X-coordinate	Y-coordinate	Z-coordinate
CADDF	147.02	165.16	37.25

The format specification in this case will be as:

```
20  FORMAT (A5,22X3F15.3)

    READ 20,(A(I),XM(I),YM(I),ZM(I),I=1,N)
```

The results will be punched with the following statement :

```
    PUNCH 20, (A(I),XG(I),YG(I),ZG(I),I=1,N)
```

The above examples show clearly that computer programming does not present any difficulty while working with a code system. If the code number is more than the specified digits it can be conveniently broken into a number of variables. With the use of A,F and I formats as indicated above, it is possible to programe any code system containing numerals, alphabets or a combination of numerals and alphabets. Model programmes were developed and run on I.B.M.1620 (available at S.E.R.C.Roorkee) with entirely satisfactory results.

CHAPTER 6.

CONCLUSIONS:

6.1. Utility of the proposed code systems:

Four code systems have been proposed in this thesis, one for specifying the block and the remaining three for photogrammetric points. The code for block specification will find use in a national organisation such as the Survey of India, where hundreds of blocks are dealt with. In such a voluminous work the block number will clearly convey all the necessary information of the block. The block numbers will further help in keeping or storing the recorded data, the concerned photograms, computer programs, etc. in a systematic and scientific manner.

The three code systems for photogrammetric points in a block are also applicable for strip triangulation. In strip triangulation as there is only one strip the first specification of strip number may be deleted from the proposed code systems namely the Number coding system, Alpha-Numeric coding system and the Alphabetic coding system. In all the coding systems, while classifying the photogrammetric points, vacant spaces have been left so that any special feature can be incorporated as they are introduced in future. The code systems will be found particularly helpful when applied to a block triangulation scheme. They have been so prepared as to present no difficulty in computer programming.

6.2. <u>Suggestions for future work</u>:

Though every care has been taken to avoid any ambiguity or blunder in framing the code systems, yet they cannot be said to be perfect unless successfully applied to an actual block triangulation scheme. It is, therefore, necessary to apply the code systems proposed in this study to actual problems. Only then the full utility of this procedure can be assessed. The author hopes that further researches on the problem will be taken up at University of Roorkee and the Survey of India in collaboration.

The three code systems presented may not be conclusive but they very well demonstrate the basic approach. Various other systems can be developed using these approaches. For example a system, exclusively for research purposes should be evolved. In this code all refinements such as Identification Index Number (weight of the photogrammetric point), precision of the ground control point should be used. A number specifying the weight of an observation could be incorporated in the code.

An interesting and useful field is open for investigation. When a computer is provided with the code number of the observation point, we have given all the specifications of the point in the computer memories. This can be used to advantage in different stages of a programme.

-:- -:- -:-

APPENDIX I.

APPLICATION OF PROPOSED CODE SYSTEMS TO AN HYPOTHETICAL BLOCK SHOWN IN FIGURE 1.

SCHEME OF OBSERVATION POINTS

STRIP NO 1, PHOTO NO 1 (FROM FIG 1)

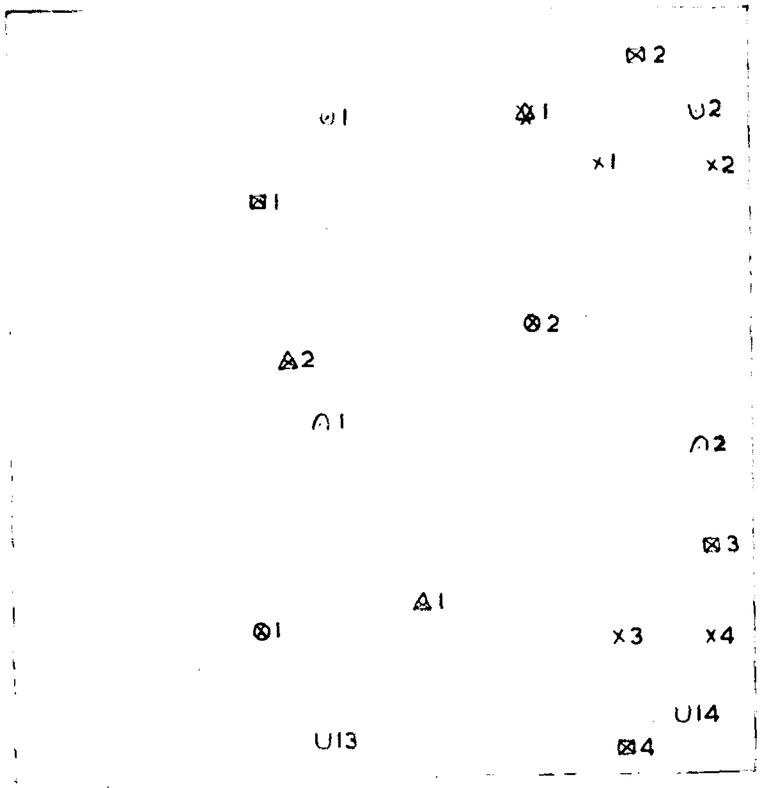


FIG. 2

STRIP NO 1, PHOTO NO. 2 (FROM FIG. 1)

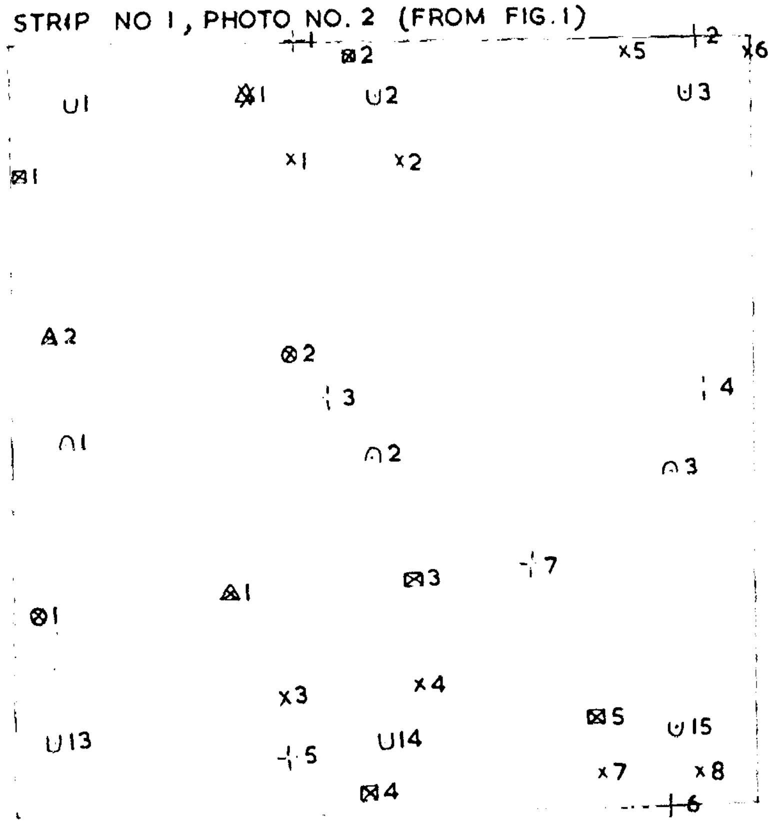


FIG. 3

TABLE NO.14

CODE DESIGNATION FOR POINTS IN PHOTO NO.1 OF STRIP 1.

[See Fig. 2 also]

S.No.	Point symbol in Index sketch	Code designation of the point: Code I Number Coding system.	Code II Alphanumeric system.	Code III Alphabetic coding system.
1	◡1	010120.001	AAI01	AABAA
2	⚠1	010140.001	AAK01	AAWAA
3	⊠2	010151.002	AAL02	AARAB
4	◡2	010122.002	AAI02	AACAB
5	×1	010108.001	AAE01	AAVAA
6	×2	010108.002	AAE02	AAVAB
7	⊠1	010151.001	AAL01	AARAA
8	⊗2	010181.002	AAV02	*
9	◬2	010172.002	AAP02	AASAB
10	∩1	010110.001	AAH01	AAEAA
11	∩2	010112.002	AAH02	AAFAB
12	⊗1	010181.001	AAU01	*
13	◬1	010172.001	AAP01	AASAA
14	⊠3	010151.003	AAL03	AARAC
15	◡13	010123.013	AAJ13	AAHAM
16	×3	010107.003	AAE03	AAVAC
17	×4	010107.004	AAE04	AAVAD
18	◡14	010125.014	AAJ14	AAIAN
19	⊠4	010151.004	AAL04	AARAD

* means that it was a level control point, hence deleted for exhibiting Alphabetic system(level control is not required in radial triangulation).

TABLE NO.15

CODE DESIGNATION FOR POINTS IN PHOTO NO.2 OF STRIP I.

[See Fig. 3 also]

S.No	Point symbol in Index sketch	Code designation of the point		
		Code I Number coding system.	Code II Alphanumeric system.	Code III Alphabetic coding system.
1	∪ 1	010221.001	ABI01	ABAAA
2	∩ 1	010211.001	ABH01	ABDAA
3	∪ 13	010224.013	ABJ13	ABGAM
4	∪ 2	010220.002	ABJ02	ABBAB
5	∩ 2	010210.002	ABH02	ABEAB
6	∪ 14	010223.014	ABJ14	ABHAN
7	∪ 3	010222.003	ABI03	ABCAC
8	∩ 3	010212.003	ABH03	ABFAC
9	∪ 15	010225.015	ABJ15	ABIAO
10	+ 1	010208.001	ABE01	■
11	+ 2	010208.002	ABE02	■
12	× 5	010207.005	ABG05	ABVAE
13	× 6	010207.006	ABG06	ABVAF
14	△ 1	010240.001	ABK01	ABWAA
15	⊠ 2	010251.002	ABL02	ABRAB
16	⊠ 1	010251.001	ABL01	ABRAA
17	× 1	010207.001	ABG01	ABVAA
18	× 2	010207.002	ABG02	ABVAB
19	△ 2	010272.002	ABP02	ABSAB
20	⊗ 2	010281.002	ABU02	■
21	+ 3	010208.003	ABE03	■

Table No. 15 contd..

Table No.15 contd.

S.No.	Point symbol	Code I	Code II	Code III
22	+ 4	010208.004	ABE04	⊠
23	△ (with A) 1	010272.001	ABP01	ABSAA
24	⊠ 3	010251.003	ABL03	ABRAC
25	⊗ 1	010281.001	ABU01	⊠
26	× 3	010207.003	ABG03	ABVAC
27	× 4	010207.004	ABG04	ABVAD
28	⊠ 5	010251.005	ABL05	ABRAE
29	+ 5	010208.005	ABE05	⊠
30	× 4	010207.004	ABG04	ABVAE
31	+ 6	010208.006	ABE06	⊠
32	× 7	010207.007	ABE07	ABVAG
33	× 8	010207.007	ABG08	ABVAH
34	⊠ 4	010251.004	ABL04	ABRAD
35	+ 7	010208.007	ABE07	⊠

⊠ means that it was a level control point, hence deleted for exhibiting Alphabetic system(level control is not required in radial triangulation).

SCHEME OF OBSERVATION POINTS

STRIP NO. 1, PHOTO NO 3 (FROM FIG 1)

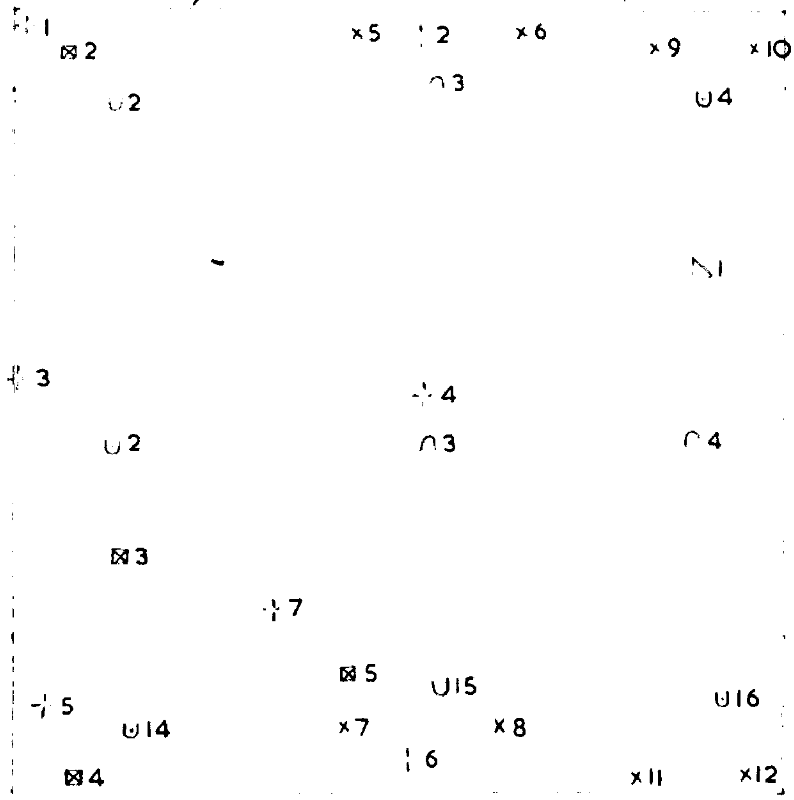


FIG. 4

STRIP NO.2, PHOTO NO.1 (FROM FIG. 1)

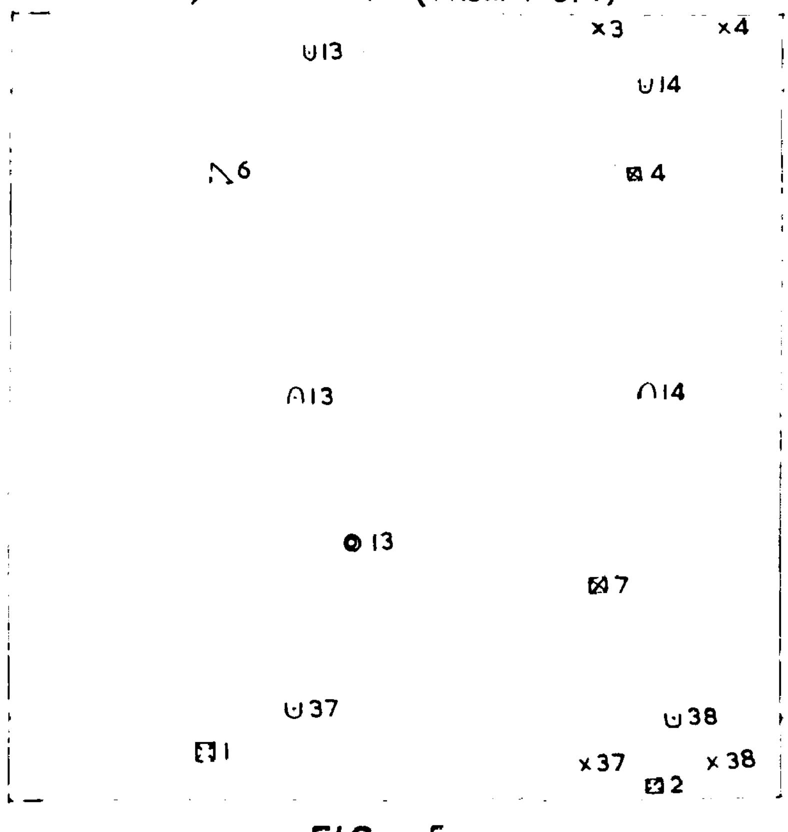


FIG. 5

TABLE NO.16

CODE DESIGNATION FOR POINTS IN PHOTO NO.3 OF STRIP 1.

[See Fig.4 also]

S.No.	Point symbol in Index sketch	Code designation of the points: Code I Number coding system.	Code II Alphanumeric system.	Code III Alphabetic coding system.
1	∔ 1	010308.001	ACE01	*
2	⊠ 2	010351.002	ACL02	ACRAB
3	◡ 2	010321.002	ACI02	ACAAB
4	× 5	010307.005	ACG05	ACVAE
5	× 6	010307.006	ACG06	ACVAF
6	∔ 2	010308.002	ACE02	*
7	◡ 3	010310.003	ACI03	ACEAC
8	× 9	010307.009	ACG09	ACVAI
9	× 10	010307.010	ACG10	ACVAJ
10	◡ 4	010322.004	ACI04	ACCAD
11	× 1	010307.001	ACG01	ACVAA
12	× 2	010307.002	ACG02	ACVAB
13	∔ 3	010308.003	ACE03	*
14	∔ 4	010308.004	ACE04	*
15	⌒ 2	010311.002	ACH02	ACDAB
16	⌒ 3	010320.003	ACH03	ACBAC
17	⌒ 4	010312.004	ACH04	ACFAD
18	⊠ 3	010351.003	ACL03	ACRAC
19	◎ 1	010386.001	ACU01	*

Table No.16 contd..

Table No.16 contd...

S.No.	Point symbol	Code I	Code II	Code III
20	⌖ 7	010308.007	ACE07	■
21	× 3	010307.003	ACG03	ACVAC
22	× 4	010307.004	ACG04	ACVAD
23	⌖ 5	010308.005	ACE05	■
24	◡ 14	010324.014	ACJ14	ACAAN
25	⊠ 4	010351.004	ACL04	ACRAD
26	⊠ 5	010351.005	ACL05	ACRAE
27	◡ 15	010323.015	ACJ15	ACHAO
28	× 7	010307.007	ACG07	ACVAG
29	× 8	010307.008	ACG08	ACVAH
30	⌖ 6	010308.006	ACE06	■
31	◡ 16	010325.016	ACJ16	ACIAP
32	× 1	010307.001	ACG01	ACVAA
33	× 2	010307.002	ACG02	ACVAB

■ means that it was a level control point, hence deleted for exhibiting Alphabetic system(level control is not required in radial triangulation).

TABLE NO. 17

CODE DESIGNATION FOR POINTS IN PHOTO NO.1 OF STRIP 2.

[See Fig.5 also]

S.No	Point symbol in Index sketch	Code designation of the point		
		Code I Number coding system.	Code II Alphanumeric system.	Code III Alphabetic coding system.
1	◡ 13	020120.013	BAI13	BABAN
2	× 3	020107.003	BAG03	BAVAC
3	× 4	020107.004	BAG04	BAVAD
4	◡ 14	020122.014	BAG14	BACAN
5	⊠ 4	020151.004	BAL04	BARAP
6	◺ 6	020167.006	BAO06	BASAP
7	◠ 13	020110.013	BAH13	BAEAN
8	◠ 14	020112.014	BAJ14	BAFAN
9	◎ 13	020186.013	BAU13	¤
10	⊠ 7	020151.007	BAL07	BARAG
11	◡ 37	020120.037	BAJ37	BAHBK
12	◡ 38	020122.038	BAJ38	BAIBL
13	× 37	020107.037	BAG37	BAVBK
14	× 38	020107.038	BAG38	BAVBL
15	⊡ 1	020152.001	BAN01	BASAA
16	⊡ 2	020152.002	BAN02	BASAB

¤ means that it was a level control point, hence deleted for exhibiting Alphabetic system (level control is not required in radial triangulation).

TABLE NO.18

CODE DESIGNATION FOR POINTS IN PHOTO NO.2 OF STRIP 2.

[See Fig. 6 also]

S.No	Point symbol in Index sketch	Code designation of the point		
		Code I Number coding system.	Code II Alphanumeric system.	Code III Alphabetic coding system.
1	◡ 13	020221.013	BBI13	BBAAM
2	× 3	020207.003	BBG03	BBVAC
3	× 4	020207.004	BBG04	BBVAD
4	◡ 14	020220.014	BBI14	BBBAN
5	⊠ 4	020251.004	BBL04	BBRAD
6	◡ 15	020222.015	BBI15	BBCAO
7	× 7	020207.007	BBG07	BBVAG
8	× 8	020207.008	BBG08	BBVAH
9	◺ 6	020267.006	BBO06	BBSAF
10	◎ 12	020286.012	BBU12	■
11	◠ 13	020211.013	BBH13	BBDAM
12	◠ 14	020210.014	BBH14	BBEAN
13	◠ 15	020212.015	BBH15	BBFAO
14	◎ 13	020286.013	BBU13	■

Table No.18 contd..

SCHEME OF OBSERVATION POINTS

STRIP NO 2, PHOTO NO.2 (FROM FIG.1)

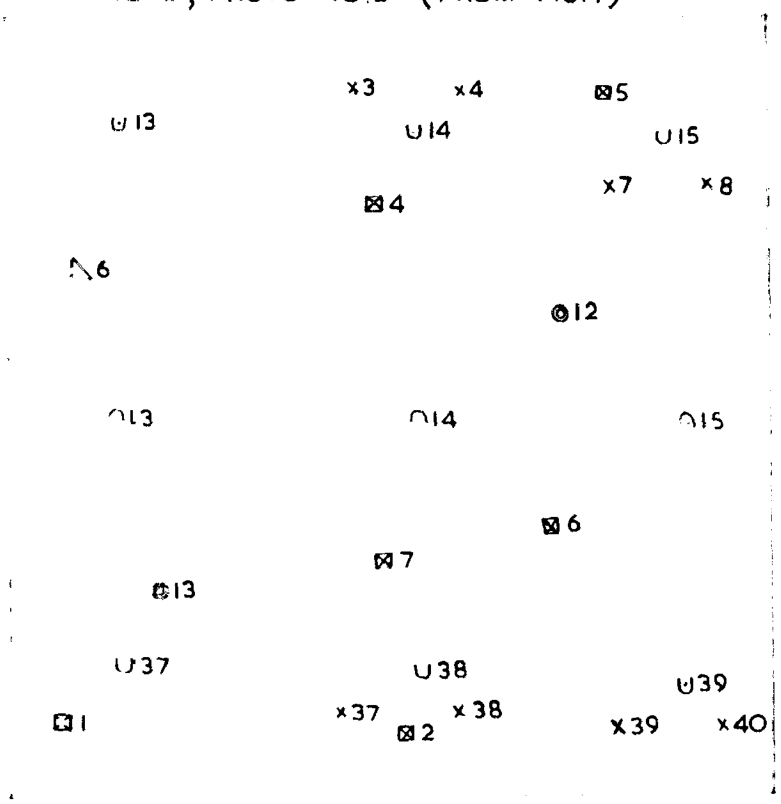


FIG. 6

STRIP NO 3, PHOTO NO 1 (FROM FIG. 1)

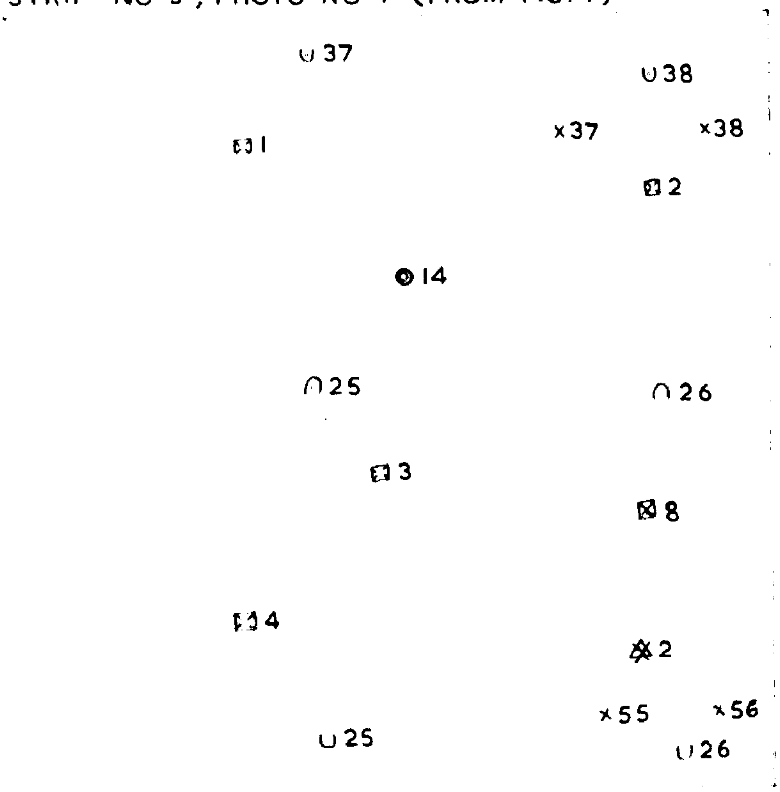


FIG. 7

TABLE NO.18

CODE DESIGNATION FOR POINTS IN PHOTO NO.2 OF STRIP 2.

[See Fig. 6 also]

S.No	Point symbol in Index sketch	Code designation of the point		
		Code I Number coding system.	Code II Alphanumeric system.	Code III Alphabetic coding system.
1	◡ 13	020221.013	BBI13	BBAAM
2	× 3	020207.003	BBG03	BBVAC
3	× 4	020207.004	BBG04	BBVAD
4	◡ 14	020220.014	BBI14	BBBAN
5	⊠ 4	020251.004	BBL04	BBRAD
6	◡ 15	020222.015	BBI15	BBCAO
7	× 7	020207.007	BBG07	BBVAG
8	× 8	020207.008	BBG08	BBVAH
9	△ 6	020267.006	BBO06	BBSAF
10	◎ 12	020286.012	BBU12	■
11	⌒ 13	020211.013	BBH13	BBDAM
12	⌒ 14	020210.014	BBH14	BBEAN
13	⌒ 15	020212.015	BBH15	BBFAO
14	◎ 13	020286.013	BBU13	■

Table No.18 contd..

Table No.18 contd...

S.No.	Point symbol	Code I	Code II	Code III
15	⊠ 7	020251.007	BBL07	BBRAG
16	⊠ 6	020251.006	BBL06	BBRAF
17	◡ 37	020224.037	BBJ37	BBGBK
18	◡ 38	020223.038	BBJ38	BBHBL
19	◡ 39	020225.037	BBJ39	BBIBM
20	× 40	020207.040	BBG40	BBVBN
21	× 39	020207.039	BBG39	BBVBM
22	× 38	020207.038	BBG38	BBVBL
23	× 37	020207.037	BBG37	BBVBK
24	⊠ 2	020252.002	BBM02	BBSAB
25	⊠ 1	020252.001	BBM01	BBSAA

* means that it was a level control point, hence deleted for exhibiting Alphabetic system(level control is not required in radial triangulation).

TABLE NO.19

CODE DESIGNATION FOR POINTS IN PHOTO NO.1 OF STRIP 3.

[See Fig. 7 also]

S.No	Point symbol in Index sketch	Code designation of the point: Code I Number coding system.	Code II Alphanumeric system.	Code III Alphabetic coding system.
1	∪ 37	030120.037	CAI37	CABBK
2	∪ 38	030122.038	CAI38	CACBL
3	× 38	030107.038	CAG38	CAVBL
4	× 37	030107.037	CAG37	CAVBK
5	⊠ 2	030152.002	CAM02	CASAB
6	⊠ 1	030152.001	CAM01	CASAA
7	◎ 14	030186.014	CAU14	■
8	∩ 25	030123.025	CAH25	CAHAW
9	∩ 26	030125.026	CAH26	CAIAZ
10	⊠ 3	030152.003	CAM03	CASAC
11	⊠ 8	030151.008	CAL08	CARAH
12	△ 2	030140.002	CAK02	CAWAB
13	⊠ 4	030152.004	CAM04	CASAD
14	∪ 25	030120.025	CAJ25	CAEAY
15	× 55	030107.055	CAG55	CAVCC
16	× 56	030107.056	CAG56	CAVCD
17	∪ 26	030122.026	CAJ26	CAFAZ

■ means that it was a level control point, hence deleted for exhibiting Alphabetic system(level control is not required in radial triangulation).

TABLE No.20

CODE DESIGNATION FOR POINTS IN PHOTO NO.2 OF STRIP 3..

[See Fig. 8 also]

S.No	Point symbol in Index sketch	Code designation of the point		
		Code I Number coding system.	Code II Alphanumeric system.	Code III Alphabetic coding system.
1	◡ 37	030221.037	CBI37	CBABK
2	◡ 38	030220.038	CBI38	CBBBL
3	◡ 39	030222039	CBI39	CBCBM
4	× 40	030207.040	CBG40	CBVBN
5	× 39	030207.039	CBG39	CBVBM
6	× 38	030207.038	CBG38	CBVBL
7	⊠ 2	030252.002	CBM02	CBSAB
8	× 37	030207.037	CBG37	CBVBK
9	◎ 14	030286.014	CBU14	■
10	◠ 25	030211.025	CBH25	CBDAY
11	⊠ 3	030252.003	CBM03	CBSAC
12	◠ 26	030210.026	CBH26	CBEAZ
13	◠ 27	030212.027	CBH27	CBFBA
14	⊠ 8	030251.008	CBL08	CBRAH
15	⊠ 4	030252.004	CBM04	CBSAD

Table No.20 contd..

SCHEME OF OBSERVATION POINTS

STRIP NO.3, PHOTO NO. 2 (FROM FIG. 1)

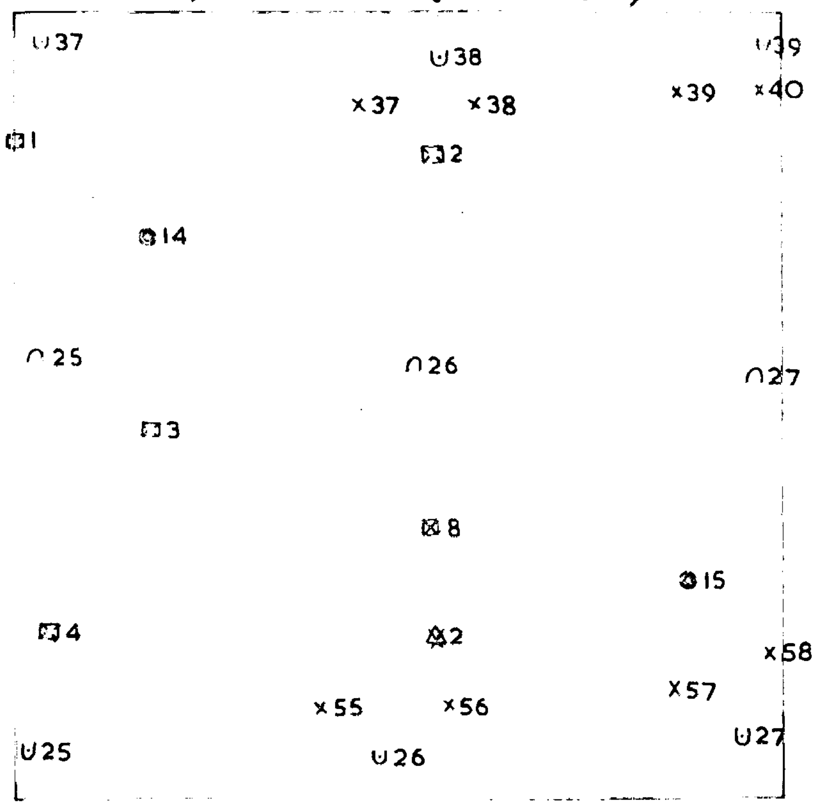


FIG. 8

TABLE No.20

CODE DESIGNATION FOR POINTS IN PHOTO NO.2 OF STRIP 3..

[See Fig. 8 also]

S.No	Point symbol in Index sketch	Code designation of the point		
		Code I Number coding system.	Code II Alphanumeric system.	Code III Alphabetic coding system.
1	∪ 37	030221.037	CBI37	CBABK
2	∪ 38	030220.038	CBI38	CBBBL
3	∪ 39	030222,039	CBI39	CBCBM
4	× 40	030207.040	CBG40	CBVBN
5	× 39	030207.039	CBG39	CBVBM
6	× 38	030207.038	CBG38	CBVBL
7	⊠ 2	030252.002	CBM02	CBSAB
8	× 37	030207.037	CBG37	CBVBK
9	◎ 14	030286.014	CBU14	[illegible]
10	∩ 25	030211.025	CBH25	CBDAY
11	⊠ 3	030252.003	CBM03	CBSAC
12	∩ 26	030210.026	CBH26	CBEAZ
13	∩ 27	030212.027	CBH27	CBFBA
14	⊠ 8	030251.008	CBL08	CBRAH
15	⊠ 4	030252.004	CBM04	CBSAD

Table No.20 contd..

Table No.20 contd..,

S.No.	Point symbol	Code I	Code II	Code III
16	⨻ 2	030240.002	CBK02	CBWAB
17	◎ 15	030286.015	CBU15	■
18	× 58	030207.058	CBG58	CBVCF
19	× 57	030207.057	CBG57	CBVCE
20	◡ 27	030225.027	CBJ27	CBIBA
21	× 55	030207.055	CBG55	CBVCC
22	× 56	030207.056	CBG56	CBVCD
23	◡ 26	030223.026	CBJ26	CBHAZ
24	◡ 25	030224.025	CBJ25	CBGAY
25	⊠ 4	030252.004	CBM04	CBSAD

■ means that it was a level control point, hence deleted for exhibiting Alphabetic system(level control is not required in radial triangulation).

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