Comparative Construction Costs in Nigeria

BY
J L MoCAHTHY

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M.Sc. THESIS

J L McCARTHY

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SUPERVISORS

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EXAMINERS

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Approved by Faculty of Engineering

Date _____

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ABSTRACT

Nigeria is a rapidly developing country with a very large construction programme. Fortunately it has considerable oil resources to provide funds for this development. However, the demand for amenities still exceeds the funds available so the development plans have to be carefully considered. To enable the plans to be drawn accurately it is necessary to establish current and projected construction costs.

The object of this study is to investigate existing construction cost patterns and from the results obtained to propose a system for defining these patterns so that they can be used as a basis for projecting future costs. Two systems were selected for detailed investigation. These are:

(a) Analysis: the analysis of costs of completed projects,

(b) Synthesis: the building up of costs using the basic costs of labour, material and plant.

The methods of measurement and analysis are discussed in the text. It is shown that synthesis provides the more accurate results and is recommended for use in Nigeria.

Acknowledgements

My grateful thanks are due to the late Professor Sir Robert Matthew my external supervisor. His original work in 1963 on behalf of the former Northern Nigerian Government inspired this research.

Thanks are also due to my present external supervisor Mr J T Gordon, the Head of the Department of Surveying, Glasgow College of Building and Printing, not only for his very helpful assistance in the preparation of this work but also for the contribution he and his College have made to the development of the quantity surveying profession in Nigeria.

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CHAPTER 1

INTRODUCTION

1.01 Comparative Construction Costs:

The motive for the research was to investigate existing construction cost patterns in Nigeria and from the results obtained to propose a system for defining these patterns so that they could be used to improve the accuracy of pre-tender estimates.

The estimates are based on cost analysis of completed buildings. Sweett[1] * has defined cost analysis as the systematic break down of costs, according to the sources from which they arise and Seeley[2] says it can permit detailed comparisons to be made between different projects and isolate the causes of differences.

Variations in building costs are due to many factors. The most important of these are:

(1) Design
(2) Specification
(3) Height
(4) Function
(5) Time
(6) Location

Variables (1) to (4) can be measured for any given project and are valued by reference to the cost analysis of completed buildings. Measures of time and location are then used to update these values by accounting for any changes in cost due to the passage of time or change in location. This research isolates the costs which are due to these two variables. Comparison of these costs establishes the cost patterns and allows the nature of the building costs to be examined. The cost patterns are defined by expressing the costs in the form of cost indices. The aim is to establish methodologies for collecting reliable cost data and for processing the data so that it is accurate enough for use in cost estimates.

* Note: The numbers refer to the bibliography at the end of the thesis.

Unfortunately there is virtually no published information on building cost data in Nigeria so it is necessary to start from the beginning and make an independent collection of cost data. The form of this cost data depends on the method selected for the preparation of the cost indices. Several methods are in use and are described in Chapter No. 2. Two of them were selected for detailed investigation to check their suitability for use in Nigeria.

The methods are:-

(1) Analysis: The analysis of the costs of completed projects.

(2) Synthesis: the building up of costs using the basic costs of labour, material and plant.

1.02 Use of Cost Indices

Matthew[5] in his 1963 Report on Building Costs to the former Government of Northern Nigeria states that before historical cost data contained in cost analysis can be used it must be adjusted to the current level of building costs by reference to a reliable building cost index. He recommended that as no building cost index of any sort existed it should be made a priority aim to establish one and maintain it at quarterly intervals. He considered that this was properly a job for a statistician who needs to be told what the index sets out to measure.

Seeley[2] says that the main function of building cost indices is to assess the differences in levels of tenders at varying dates and to adjust analysis of past costs of buildings to current prices and that future trends in price levels may also be assessed.

In Nigeria due to the absence of building cost indices and with rigid Government accounting systems quantity surveyors have to include large contingency or safety factors in their estimates to allow for any unforeseen costs which may arise. Under Nigerian conditions safety factors range from 10% to 15% of the total capital vote for construction work. If as is often the case, the contingency factor is not required then the money reserved for this purpose has been wasted in the sense that it has been held back in the capital votes and not used to construct the amenities the people require. Cost indices by bridging the gap between known past construction costs and predicted future/

future costs can reduce considerably the need for contingency factors.

Figure 1.01 is an example of the use of location and time indices.

The aim of this research is to identify the best method of producing building cost indices in Nigeria.

1.03 Collection and Processing of Cost Data in Nigeria

The research reported here was undertaken in several phases. The first phase consisted of collecting and processing suitable building cost data using the techniques of analysis and synthesis. This work is described in Chapters Nos. 3 to 5.

The second phase of the work comprised the assembly of the cost data and its presentation in a form which allowed the various results to be easily compared. This involved the preparation of cost indices for different types of buildings at different locations and dates. Details of this work are contained in Chapter No. 6.

The third phase was the statistical analysis of the cost data to determine its reliability for use in forecasting future construction costs.

The thesis concludes with detailed proposals for the preparation of building cost indices in Nigeria and a review of current publications concerning the use of multiple regression analysis as a means of constructing mathematical models which would take account of all the variables affecting building costs.

PROJECTED COST
KANO 1976

A = COST ZARIA 1970 = ₦ 20,000

B = TIME INDEX 1970 = 120

C = TIME INDEX 1976 = 190

D = LOCATION INDEX ZARIA = 130

E = LOCATION INDEX KANO = 140

P = PROJECTED COST

$= A + A \left(\frac{C-B}{B} + \frac{E-D}{D}\right)$

$= 20{,}000 + 20{,}000 \left(\frac{190-120}{120} + \frac{140-130}{130}\right)$

$= 20{,}000 + 13{,}138$

$= \underline{₦\ 33{,}138}$

FIG. 1.01

CHAPTER 2

THE PREPARATION OF BUILDING COST INDICES

2.01 The Construction of Cost Indices

Before attempting to prepare building cost indices it is necessary to make a detailed study of all the factors affecting construction costs. These factors include the movement of tender prices of buildings of all types over the years; the isolation of the effects of variation in design and type of building; the location in the country and the form of contract; the relationship between the movements in tender prices and changes in building costs. It is also necessary to consider carefully suitable methods of constructing indices of building costs and whether separate indices are required for different conditions.

Jupp[4] reporting the work of a group formed to study construction costs describes how preliminary investigation of the study group centred around three main concepts of building costs or prices; firstly, the cost to the builder of carrying out a specified job; secondly, the cost to the purchaser or client of the building of a similar specified amount of work of constant quality and quantity; and thirdly the cost to the client measured in terms of functional units.

The conclusion of the study group was that most users of indices require the second approach - indices reflecting market prices paid by the client. Furthermore, a series of index numbers covering prices of different categories of building seemed to be more useful for the majority of purposes than one general index relating to all building and construction. It might also be desirable to have separate index numbers for different localities. The group also concluded that there are serious problems associated with the construction of index numbers based on labour and material costs notably concerning productivity and plant, overhead costs and profit. Regarding indices based on full repricing of bills, quantity differences and variability of pricing between bills could lead to high coefficients of variation, although a price variability might be reduced by stratification into geographical areas. The cost of constructing indices by the full repricing of bills would be dependent upon the size of the sample chosen and would probably be very high. However, Jupp[4] has pointed out that the use of computer for repricing might reduce this cost considerably. It concludes that it seems likely that indices based on short lists of items selected from bills reflect reasonably well the trends in prices derived from indices based on full bills and that the use of tender prices/

prices for index construction involves isolation of the effects of quantity and quality.

2.02 Sources and Nature of Cost Indices

The cost data required for the preparation of building cost indices can be drawn from many sources. The most important are:

(a) Government Statistics: indices can be based on the statistics of earnings in the building industry adjusted for changes in productivity combined with price indices for construction materials. This type will reflect changes in market conditions but will not take account of local conditions, variations for different building types or different types of contract.

(b) Government Departments: indices can be based on an average of tenders received but it is impractical in one index to make allowances for regional variations and differences in building types and contractual arrangements.

(c) Actual Costs of Labour and Materials: these indices can be based on the basic daily wage rates adjusted for holidays with pay, sick leave etc. for building labour, adjusted to allow for changes in productivity and material prices to which appropriate cost weighting factors are applied. A full description of this method is contained in Appendix No. 1.

This data may also be used for repricing bills of quantities.

Examples of indices based on these sources are contained in references 6, 7, 8, 9, 10 and 12.

Sweett[11] has described how he compiles his own price indices from all-in labour costs of building, electrical, heating and ventilating operatives and plant and material costs all suitably weighted according to the type of job. For instance, a typical contract for an office block could be made up of 33% building labour, 5% mechanical services, 5% plant and 57% materials.

2.03 Building Cost Indices in Nigeria

There are several methods which could be used for the preparation of building cost indices in Nigeria. These may be broadly classified as follows:-

(a) Unit prices in bills of quantities: These indices will reflect changes in labour and material costs, productivity and market conditions, but not changes in specification or methods of building unless specifically adjusted.

(b) Recorded cost of completed buildings: These indices will reflect changes in all costs of construction including changes in specification and methods of building. They must, however, be prepared for standard types of building and are accurate only for the type of building to which they refer.

(c) Changes in cost of labour: Such indices will not reflect changes in specification or methods of building over the years and by themselves will not show changes in productivity and market conditions.

The use of indices based on changes in the cost of labour and material (c) was rejected due to the difficulties which would be encountered in making adjustments for changes in productivity and market conditions. Changes in productivity are usually measured by reference to published statistics giving details of the gross annual output of the building industry and of the number of operatives employed in producing the output. Changes in market conditions can be measured from statistics giving details of the value of new construction work placed during a given period. It can also be measured by reference to changes in tender levels for a large number of contracts for the same type of building. The adjustment factor in the Building Cost Information Service index is calculated from the trends of tenders for local authority housing.

In Nigeria adjustments of this kind would not be practical due to the shortage of published building cost data. However, a detailed description of the method of preparing this type of index and its accompanying cost analysis is included in appendix No. 1 for reference.

Investigation proceeded using alternatives (a) and (b). To construct indices based on unit prices a bill of quantities was obtained for a small/

small building and a detailed synthesis was prepared for each unit rate based on the quantities of labour, material, plant, overheads and profit required for each item. This information was placed on computer store and a programme was written which would allow the synthesis to be varied to take account of changes in labour and material costs due to the variables time and location. This method is described in detail in Chapters No. 3 and 4.

To construct indices based on costs of completed buildings cost data in elemental form, was obtained for more than eight hundred buildings in Nigeria. The buildings selected were all educational buildings as indices based on historical costs are accurate only if prepared for specific types of buildings. This cost data was used to calculate costs per square metre of floor area and these were then expressed in the form of cost indices. This method is described in detail in Chapter No. 5.

CHAPTER 3

UNIT RATE METHOD

SOURCE AND COLLECTION OF COST DATA

3.01 Method

The Unit Rate method rests on the philosophy that building cost data can be synthesised by using actual costs of labour, material and plant and estimated labour outputs. This would ensure that the results are based on data which is known to be accurate as opposed to data obtained from contractors tenders where the value of the data would depend on the technical ability of the individual who prepared the tender. The method requires the collection of labour and material costs and labour outputs.

3.02 Source of Labour Costs

There have been two national wage awards in Nigeria during the past five years. One was the Adebo award the final increase of which was announced in November 1971 and the Udoji award in April 1974. Between these two dates wage rates were maintained at the Adebo level by Government decree. It should be noted, however, that the Udoji award was not announced until January 1975 and back dated to April 1974. All the calculations therefore were based on the Adebo rates. These rates are shown in figure 3.01 and 3.02. Details are given of the rates to be paid to Artisans and non-qualified artisans and also the plus rates to be paid to semi-skilled labour. Details of the rates to be paid to general labour and watchmen are also shown. The award divided the country up into three zones, as shown, and specified minimum rates for each area for general labour. These rates are used in the computation of the Unit Rate Method.

3.03 Source of Material Costs

The material prices were obtained direct from Builders Suppliers in various parts of the country in December 1972, August 1973 and August 1974. The method of collection is described in 3.06.

3.04 Source of Labour outputs

The labour outputs are based on data compiled in East and West Africa. The original outputs were obtained from tender analysis prepared by Messrs Stirling Astaldi Limited for building contracts in East Africa between the years 1956 and 1963. These analysis are of the same type as those described in Chapter No. 3. It was the practice of the company/

company to prepare detailed analysed build-ups for each major project. In each case the analyses were prepared by updating information used for previous projects with the result that the labour outputs were continually being improved and made more accurate with each new project.
Subsequently these analyses were used in Nigeria and further altered and updated as a result of observations on building sites and consultation with contractors.

3.05 Comparison of Nigerian and British Labour Outputs and Costs

The following details fig. 3.03 of some of the labour outputs used and of current outputs in Britain are given for the purpose of cost comparison. The outputs given for Britain are those which were published by Wainwright[13]. It will be seen that for general labour work the outputs are somewhat the same. For semi-skilled work the output in Britain is about double and for skilled work the outputs vary from double to three times the Nigeria outputs. Matthew in a report published in 1963[3] stated that at that time labour costs in Nigeria were about one-ninth of those in Britain and that productivity in Nigeria was generally about one third that of Britain.

NATIONAL JOINT INDUSTRIAL COUNCIL FOR THE
BUILDING AND CIVIL ENGINEERING INDUSTRY
IN NIGERIA

MEMORANDUM OF AGREEMENT

(1) This Agreement is dated the 10th day of NOVEMBER 1971

(2) IT IS HEREBY AGREED AND DECLARED THAT the following MINIMUM WAGE RATES shall be immediately incorporated into the National Joint Industrial Council Agreement on the Terms and Conditions of Service for all Manual Workers in the Building and Civil Engineering Industry in Nigeria dated 27th July 1966, as amended from time to time.

(3) IT IS HEREBY AGREED AND DECLARED that every daily-rated Worker, regardless of their present rate of pay, except General Labourers and Watchmen, shall receive an increment of 2s 4d per day with effect from 1st September 1971. Such increment shall be included in calculation of overtime pay and pay for Public Holidays.

(4) The following MINIMUM WAGE RATES shall be read as APPENDIX II on pages 13 & 14 of the National Joint Industrial Council Agreement, in place of the existing rates:

MINIMUM WAGE RATES

The minimum rates of wages, with effect from 1st September 1971, are as follows:-

THROUGHOUT NIGERIA

(i) Artisans shall receive 12s 4d per day
(ii) Non-Qualified Artisans shall receive 11s 4d per day
(iii) Plant Operators and Drivers shall receive 11s 1d per day
(iv) The following plus rates shall be paid in addition to the rate paid for General Labour under heading (v) below to workers engaged in the following trades:

plus 7d per day	Steel Frame Erectors
plus 6d per day	Steel Bender and Fixers and Scaffolders
plus 4d per day	Brush Hands
plus 3d per day	Electricians Mates and Plumbers Mates
plus 3d per day	Mixer Drivers
plus 3d per day	Block Makers
Conservancy Allowance of 3d per day	Nightsoil Men

In the case of Steel Frame Erectors, the plus rate is for any building with a height of up to 40 ft. An additional plus rate of 3d per day is payable for every additional height of 30 ft.

Fig. 3.01

ADEBO WAGE AWARD

(v) Minimum Rates for General Labour and Watchmen, with effect from 1st September, 1971, are as follows:

Zone 1	General Labour	Watchmen
Lagos State	10/- ₦1.00	11/6d ₦1.15
Zone 2		
Western State, Mid-Western State, East-Central State, Rivers State, South-Eastern State, Benue-Plateau State, Kano State, North-Central State	8/9d 88k	9/10d 98k
Zone 3		
Kwara State, North-Eastern State, North-Western State	7/-d 70k	8/4d 83k

(vi) Apprentices:

The wages paid to Apprentices, with effect from 1st September 1971 shall be as follows:

1st year	5/4d per day
2nd year	6/4d per day
3rd year	7/10 per day
4th year	8/10 per day
5th year	10/4 per day

(5) IT IS FURTHER AGREED AND DECLARED that these new rates shall be effective from the 1st day of September 1971 and that any arrears of wages shall be paid to all workers not later than 22nd December 1971.

(6) IT IS ALSO FURTHER AGREED AND DECLARED that this Agreement shall apply to all workers employed as at 1st September 1971 and that any worker whose employment is terminated after that date shall be entitled to receive these arrears.

EXPLANATORY NOTE:

This Agreement provides for a general award of 2/4d per day for all workers in the Building and Civil Engineering Industry in Nigeria, with the exception of General Labourers employed in Zones II and III who must receive an increment to bring their wages up to the new minimum rates for their Zones.

Fig. 3.02

LABOUR OUTPUTS

GENERAL LABOUR

ITEM	OUTPUT	
	NIGERIA	BRITAIN
1. Excavate oversite average 150 mm deep.	4 M^3/day	4 M^3/day
2. Excavate trench not exceeding 1.50 m deep.	3 M^3/day	2½ M^3/day
3. Return, fill and ram excavated material.	4 M^3/day	8 M^3/day
4. Cut, bend and fix 12 mm diameter mild steel rod reinforcement.	30 days/tonne	16 days/tonne

ARTISANS

ITEM	OUTPUT	
	NIGERIA	BRITAIN
1. Formwork to soffits of slab	5 M^2/day	10 M^2/day
2. Blockwork 100 mm thick per block	60/day	122/day
3. Cement and sand screed	30 M^2/day	32 M^2/day
4. Glazing	2 M^2/day	6½ M^2/day
5. Painting	40 M^2/day	96 M^2/day

Fig. 3.03

3.06 Collection of Material Costs

Quantity surveying students, who acted as field enumerators during their vacations, collected the material costs. The standard pro-forma fig. 3.04 was issued to the students and was used to record the cost data. Provision was made on the form for recording a range of prices to ensure that average costs were obtained. The data was collected in December 1972, August 1973 and August 1974.

This method of collection was found to be less than ideal. The use of a large number of voluntary enumerators made it difficult to ensure that the data was collected under uniform conditions. Additionally it was difficult to ensure that the data was collected from the same source on each occasion. It was not possible to regulate the time periods as collection had to be done during vacations. This is a major problem in the construction of building cost indices. Wrobel[14] says that as much of the data used for the B.C.I.S. index is provided by subscribers it may not have been collected under conditions of uniformity such as a statistician would require.

To overcome this problem the University Research Committee was requested to provide a grant to cover the costs of a series of country wide tours by the staff of the quantity surveying section to obtain material costs and to check productivity and market conditions. Unfortunately this request was not granted. However, in spite of these difficulties the cost data will indicate the degree of accuracy which can be achieved using a unit rate method. The proposals for the preparation of cost indices include the use of trained enumerators covering the same locations at regulated intervals.

BUILDING MATERIAL PRICES

NAME: ABUBAKAR, MB

TOWN: KANO STATE: KANO DATE: AUGUST '73

		LOW	MEDIUM	HIGH	REMARKS
1.	Cement per cwt.	₦2.50	₦3.00	₦3.30	Ex-stock
2.	Sand per c.y	₦1.20	₦1.20	₦1.40	"
3.	⅜" Aggregate per c.y.	₦4.00	₦4.00	₦4.50	On site
4.	¾" Ditto per c.y.	₦5.20	₦5.20	₦5.20	" "
5.	1" Ditto per c.y	₦8.20	₦8.30	₦8.30	" "
6.	1½" Ditto per c.y				
7.	¼" Steel rods per ton	₦210	₦216	₦230	Ex-stock
8.	⅜" Ditto per ton	₦215	₦220	₦232	" "
9.	½" Ditto per ton	₦200	₦208	₦215	" "
10.	¾" Ditto per ton	₦200	₦208	₦215	" "
11.	1" Ditto per ton	₦200	₦208	₦215	" "
12.	1¼" Ditto per ton	₦196	₦200	₦204	" "
13.	1½" Ditto per ton	₦196	₦200	₦204	" "
14.	Formwork timber -- State species per c.ft.	₦1.80	₦2.00	₦2.00	" "
15.	Joinery timber Mahogany per c.ft.	₦4.30	₦4.30	₦4.50	" "
16.	Hard Board per sheet sizes 8'-0" x 4'-0"	₦2.10	₦2.10	₦2.30	" "
17.	Celotex Board per sheet size 8'-0" x 4'-0"	₦2.90	₦3.00	₦3.10	" "
18.	Hollow conc.blocks 18" x 9" x 4"	₦0.16	₦0.16	₦0.16	On site
	18" x 9" x 6"	₦0.19	₦0.19	₦0.20	" "
	18" x 9" x 9"	₦0.23	₦0.23	₦0.24	" "
19.	Light Supersix Asbestos Roof Sheets 10'-0" long per sheet	₦5.19	₦5.30	₦5.50	Ex-stock
20.	20 S.W.G. Flagspan Aluminium 10/3" pitch circular profile roof sheets 10/0" long per sheet	₦2.70	₦3.00	₦3.00	" "
21.	6" x 6" White Glazed wall tiles per box of 100	₦8.50	₦11.05	₦11.05	" "
22.	24 oz. Clear Sheet Glass per sheet size 24" x 24"	₦1.15	₦1.15	₦1.20	" "
23.	Emulsion Paint per gall.	₦8.00	₦8.03	₦8.10	" "
24.	Gloss paint	₦9.18	₦9.20	₦9.30	" "

Note: Remarks column should state if prices are on Site or Ex-Stock

Fig. 3.04

CHAPTER 4

UNIT RATE METHOD - PROCESSING OF COST DATA

4.01 Preparation of Detailed Cost Analysis:

The object is to be able to obtain the cost of a completed building by using unit rates for each item of construction work. The first step is to obtain a bill of quantities of a building which was typical of the kind of construction used in Nigeria. For the purposes of this research the building chosen is a low cost Local Education Authority Classroom designed by the Ministry of Works and Housing, Kaduna. Permanent materials were used in the design. This was chosen because it was a simple design which could be priced accurately within the limits of the cost data available. The measured items in a bill of quantities follow the same sequence as the operations performed by the Contractor in constructing the building. First he removes the top soil, then he digs the trenches, pours the foundations, builds the rising walls etc. To enable the bill of quantities to be priced detailed price analysis were prepared using basic costs of labour and materials for each of these work items following the same sequence. By substituting actual costs of labour and materials in the analysis unit rates were synthesised for each work item.

A separate synthesis is required for each item as they can be labour only such as excavation or labour and material such as concrete and within each group different types or quantities of material or grade of labour are required. Before preparing the synthesis for each work item it is necessary to calculate a cost per day of general labourers and Artisans so that this can be included in each work item.

The analysis prepared included the following items:-

LABOUR

1. General labour cost per day i.e. basic cost plus cost of annual holidays, public holidays, sick pay etc.
2. Artisan cost per day, a similar calculation to No.1 using basic cost of an artisan per day.

EXCAVATION

3. Excavate over site average 6" deep and spread and level per square yard.
4. Excavate surface trench not exceeding 5'-0" deep per cubic yard.
5. Return, fill and ram or spread and level surplus excavated material per cubic yard.

CONCRETE/

CONCRETE REINFORCEMENT AND FORMWORK

6. Cost of owning and operating a 10/7 concrete mixer per hour.
7. Cost of mixing concrete with a 10/7 concrete mixer per cubic yard.
8. Cost of placing concrete in foundation per cubic yard.
9. Cost of placing concrete in superstructure per cubic yard.
10. Cost of cement delivered to site per ton.
11. Cost of concrete (1:3:6 - 1½ Aggs.)
12. Cost of concrete (1:2:4 - ¾" Aggs.)
13. Plain in-situ concrete (1:3:6 - 1½" Aggs.) in foundation per cubic yard.
14. Reinforced in-situ concrete (1:2:4 - ¾" Aggs.) in superstructure per cubic yard.
15. ¼" Diameter mild steel rod reinforcement including bends, hooks, tying wire, distance blocks and ordinary spacers in wall reinforcement per cwt.
16. ½" Diameter mild steel rod reinforcement and ditto per cwt.
17. Sawn formwork to horizontal soffits of slab for square yard.
18. Extra over shuttered face of concrete for fair face finish per square yard.

BLOCKWORK

19. 6" Hollow concrete block walling in cement mortar (1:6) per square yard.
20. 9" Hollow concrete block walling in cement mortar (1:6) per square yard.
21. Extra over hollow concrete block walling for building fair face and pointing in cement mortar (1:6) per square yard.
22. 9" Hollow concrete block walling in cement mortar (1:6) with all cavities filled solid with concrete (1:2:4 - ¾" Aggs.) per square yard.

ROOFING

23. Light supersix corrugated asbestos roof sheeting fixed to hardwood battens with galvanised mild steel drive screws and washers per square yard.
24. 20 S.W.G. Flagspan aluminium 10/3 pitch circular profile roof sheeting fixed to hardwood purlins with galvanised mild steel drive screws and washers per square yard.

PLASTERING/

PLASTERING

25. ½" Cement and sand (1:3) render on block walls per square yard.
26. Tyrolean render on concrete block walls externally per square yard.
27. 1¼"Cement and sand (1:4) flooring laid in one coat and trowelled smooth on concrete bed per square yard.
28. 6" x 6" White glazed wall tiling fixed with adhesive on screeded backing measured separately per square yard.

GLAZING AND PAINTING

29. 24 oz. clear sheet glass and glazing to metal with putty per square foot.
30. Prepare and apply two coats of emulsion paint on rendered walls per square yard.

CARPENTRY AND JOINERY

31. 5" x 2" Hardwood door frames per lineal foot.
32. 6" x 2" Hardwood purlins per lineal foot.

Full details of all these analyses are contained in the computer print out bound in Volume No. 2 submitted in support of this thesis. A typical analysis of a work item is as follows:-

9" Hollow concrete block walling in cement mortar (1:6) per square yard.

(Imperial units are used as these were current at the time the work was done. Future work will be based on metric units.)

Take 100 s. ft.		₦	K
$\frac{100}{1.50 \times 0.75}$ = 89 No.			
89 No. blocks @ 20K per block on site	=	17	80
Add Waste 5%	=	0	89
Cost of mortar 8½ c.ft @ 46K per c.ft.	=	3	80
Add Waste 10%	=	0	38

Labour

2 Masons @ ₦1.54 per day =	₦ 3.08
2 Labourers @ ₦1.11 per day=	₦ 2.22
	₦ 5.30
Add 5% for tools	₦ 0.27
Cost of gang per day =	₦ 5.57

Output 100 blocks per day

∴ per 100 s.ft.

= $\frac{5.57}{100}$ x 89	=	4	96
		27	83
Add 25% General overheads and profit		6	96
per 100 square ft.	=	34	79
per sq. ft.	=	0	35
Per sq. yard	=	₦ 3	15

4.02/

4.02 Computer Programme - General Information

A computer programme "Comparative Construction Costs" was written in standard FORTRAN 1900 to perform the synthesis required to produce unit rates for each work item listed in Section 4.01. The programme will also update the synthesis to take account of changes in cost due to the variables time and location. The synthesis was originally prepared in December 1972 and updated in August 1973 and August 1974 using labour and material cost data collected as described in Chapter No. 3. The resulting print out comprised detailed price schedules for each of the main geographical centres in the country for the years 1972, 1973 and 1974. The print out is somewhat bulky as it was designed not only for this research but also so that each student who participated in gathering cost data could have a detailed price analysis of construction costs in his home area for each of the dates listed above.

4.03 Computer Programme - Method

There are two phases to the programme:-
The first is the computation of the cost per day of General Labour and Artisans. This is performed by using the basic cost per day at a particular time and location and adding on or allowing for the various additional benefits which may have to be paid. A Schematic diagram of this operation is shown in Fig. 4.01. The second phase is the computation of the synthesis of each work item using the labour costs computed in Phase I and the costs of material and plant for that location and time. Fig. 4.02 is a flow chart showing the arrangement of the synthesis of the work items. A general listing of the programme is contained in Appendix No. 2 to this thesis.

4.04 Computer programme - Required Input Data

The input data required for the synthesis of a work item by this programme is:

The basic cost of General Labour per day.
The basic cost of Artisans per day.
The labour output for each operation.
The cost per unit of material.
The waste factor on the material.
The cost per unit of plant.
The output per unit of the plant.
The percentage to be added for general overheads and profit.

4.05/

4.05 Computer Programme - Output Data

The programme print out contains the following information for each time and location:-

A detailed synthesis of the cost of general labour.

A detailed synthesis of the cost of artisans.

Detailed syntheses of the costs of each of the work items listed in Section 4.01.

4.06 Computer Programme - Limitations

The syntheses are limited to those work items included in the general listing of the programme. Additional work items may be added as required.

4.07 Cost of Complete Building

The synthesis of the work items produced by the computer programme are used to price a copy of the bill of quantities for the low cost classroom for each time and location. A typical priced bill of quantities, Sokoto 1974, is shown in Fig. 4.03. This aspect of the work could have been included as a third phase in the computer programme but was excluded partly due to time limitations on the use of the computer and because the amount of work required for this research could be done manually. The totals of the bills of quantities are then expressed as costs per square metre of floor area by dividing the total cost by the total floor area, and converted to an index relative to a base year or location as described in Chapter No. 5.

SYNTHESIS OF GENERAL LABOUR COST

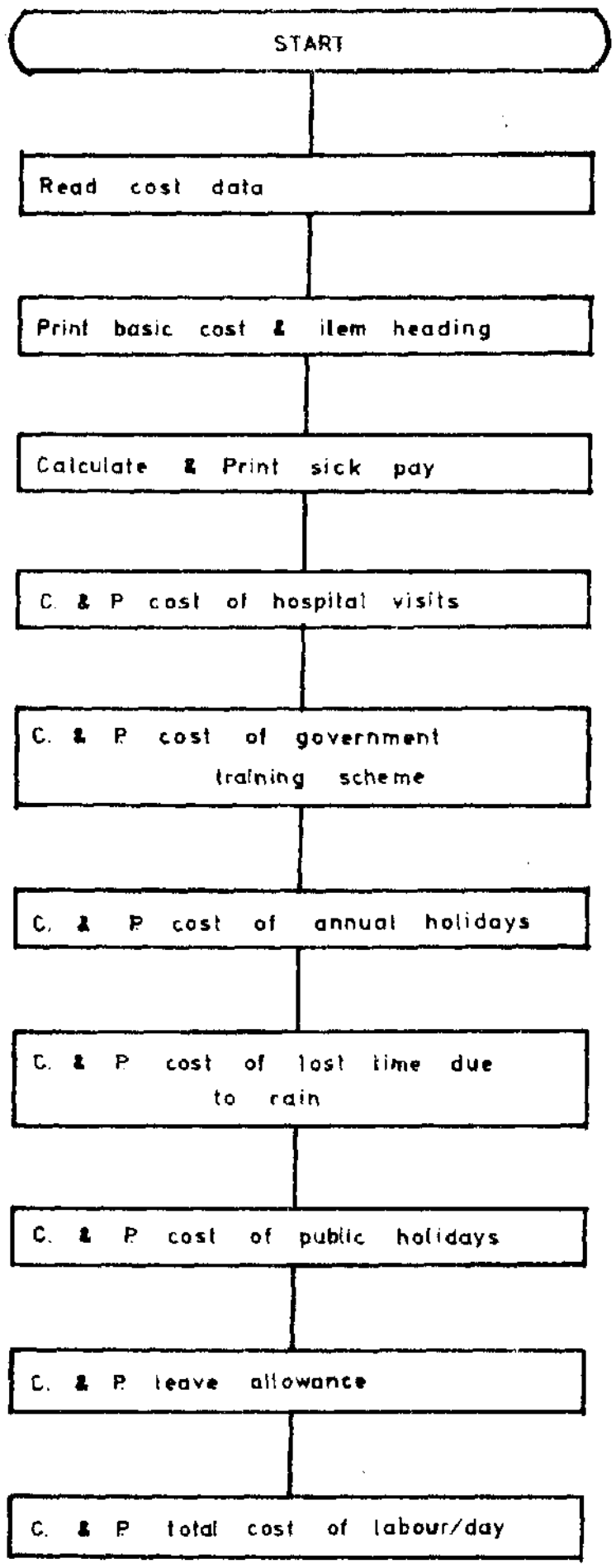


Fig. 4.01.

SYNTHESIS OF WORK ITEM COST

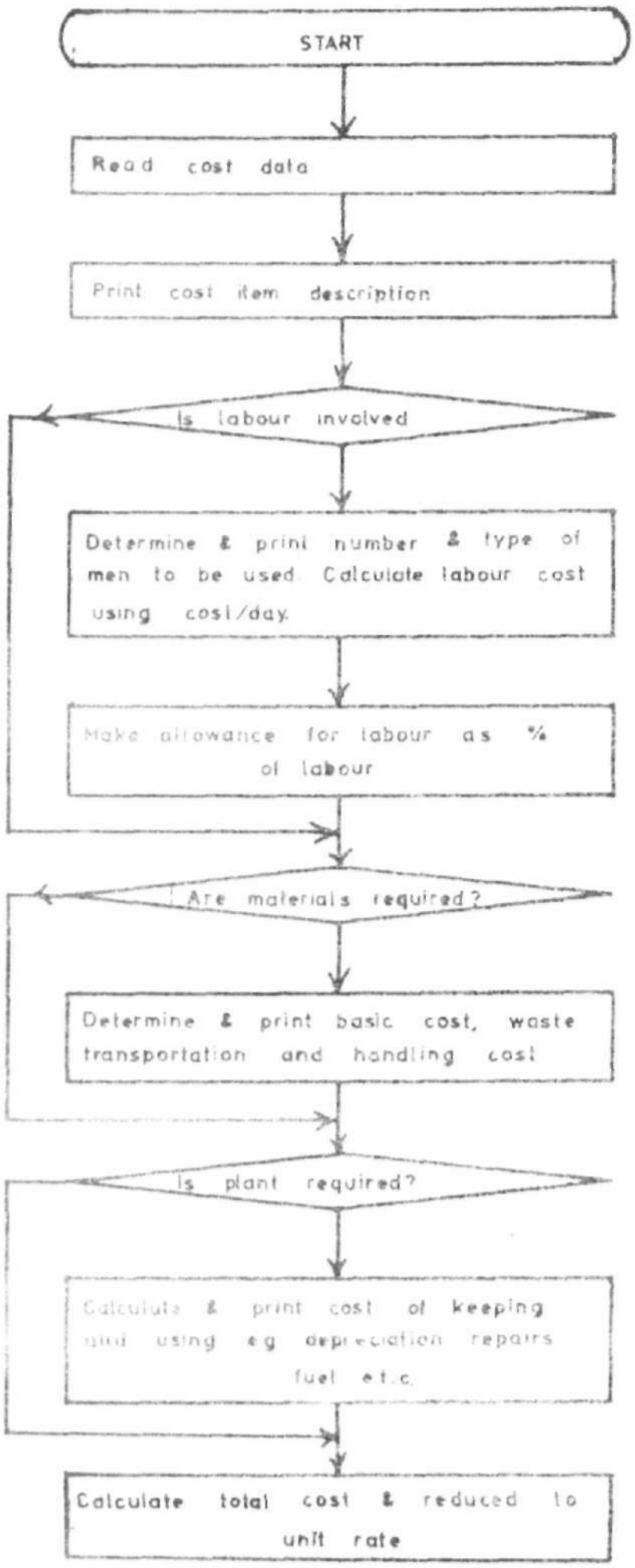


Fig 4.02

SOKOTO

1974

₦ 2495.78

Fig. 4.03

BILL No. 2

SUBSTRUCTURE - NORMAL SOIL CONDITIONS

WORKS UP TO AND INCLUDING GROUND FLOOR SLAB

EXCAVATION AND EARTHWORK

					₦
A	Excavate oversite to remove vegetable soil average 6" deep	71	Sq.yd	0.12	8.52
B	Excavate trench for foundation commencing from 6" below ground level and not exceeding 5'0" deep.	2	Cu. yd	0.43	0.86
C	Remove surplus excavated material from site	14	Cu. yd	0.32	4.48
D	6" Rock laterite hardcore fill well rammed and consolidated.	60	Sq. yrd	0.60	36.00
	CONCRETE WORK				
	REINFORCED INSITU CONCRETE				
	Reinforced concrete (1:3:6 - ¾" aggregate (reinforcement and formwork measured separately) in:				
E	Foundation	5	Cu. yd	18.00	90.00
F	3" Bed	71	Sq. yd	1.50	106.50
	REINFORCEMENT				
	Single layer BRC mesh fabric reinforcement B.S. No. 124 with 6" side laps and 18" end laps (measured net) in:				
G	Bed	88	Sq. yd	0.90	79.20
	FORMWORK				
	Sawn formwork to:				
H	Edge 12" high	34	Lin.yd	1.00	34.00
	SUNDRIES				
J	½" Fibreboard expansion joint in 3" concrete bed including necessary formwork	24	Lin. yd.	0.20	4.80
	DECORATION				
	Prepare, prime and paint two coats of emulsion paint externally on:				
K	Concrete plinth	12	Sq. yd	0.58	6.96
	Substructure - NORMAL SOIL Carried to SUMMARY		₦		371.32

BILL NO. 4

SUPERSTRUCTURE

	BLOCKWORK				
	Hollow sandcrete blockwork				₦
A	6" Wall	79	Sq. yd	5.04	398.16
B	6" Wall in beam filling	13	Sq. yd	3.09	40.17
C	Extra over 6" wall for filling cavities solid with concrete (1:3:6 – ¼" aggregate	9	Sq. yd.	4.70	42.30
D	Extra over blockwork for fair face	86	Sq. yd.	0.18	15.48
	CONCRETE WORK				
	REINFORCED INSITU CONCRETE				
	Reinforced Concrete (1:2:4 – ¾" aggregate) (reinforcement and formwork measured separately) in:				
E	Ring beam	1	Cu. yd.	40.27	40.27
	REINFORCEMENT				
	Mild steel round bar reinforcement in reinforced concrete beam and cavities of hollow block walling:				
F	⅜" Bar	1¼	Cwt.	32.48	40.60
	FORMWORK				
	Sawn formwork to:				
G	Sides of beam	11	Sq. yd	3.42	37.62
	REINFORCED PRECAST CONCRETE				
	Reinforced precast concrete (1:2:4 – ¾" aggregate)in:				
H	6" x 6" Lintel with 1 No. ⅜" mild steel round bar.	11	Lin. yd	0.60	6.60
	ROOFING				
	ALUMINIUM				
	24 Gauge longspan 'Flag' corrugated roof sheeting with one corrugation side lap (measured net) fixed in accordance with manufacturer's instructions to timber.				
	Roofing	83	Sq. yd	9.72	806.76
	Carried to COLLECTION				₦ 1427.96

Superstructure (contd.) Bill No. 4

CARPENTRY AND JOINERY

	Wrought Hardwood				₦
A	6" x 2" Purlin	19	cub.ft	3.00	57.00
B	9" x 2" Rafter	15	cub. ft	3.00	45.00
C	6" x 1½" Fascia	109	Lin.ft	0.23	25.07
D	10' x 2" Fascia	71	Lin.ft.	0.50	35.50
E	6" x 3" x 2" Cleat	35	No.	0.40	14.00
	SUNDRIES				
F	½" Diameter holding down bolt 16" long one end ragged and built into concrete ring beam other end threaded with nut and 3" x 2" x ¼" mild steel plated washer including drilling hardwood rafter	10	No.	1.00	10.00
	METALWORK				
	DOORS AND WINDOWS				
	Crittal-Hope or equal paint finish standard steeltropical doors and windows both with steel frames.				
G	Door size 2'7"x 6'10" high with knob handles lock and keys.	1	No.	40.00	40.00
H	Window type ZNC7P size 4'0¾" x 3'0⅜" high	5	No.	36.00	180.00
	PLASTERWORK				
	INTERNAL WORK				
	RENDERING				
	Cement and sand (1:3) on:				
J	Wall	98	Sq.yd	0.90	88.20
K	Extra over render for dubbing out 1" to form blackboard	7	Sq. yd	1.30	9.10
L	Wall over 3" and not exceeding 6" wide	29	Lin.yd	0.15	4.35
					₦ 508.22

Carried to COLLECTION

Superstructure (contd.) Bill No. 4

PAINTING

INTERNAL WORK

	Prepare, prime and paint two coats of emulsion paint on:				₦
A	Rendered wall	103	Sq. yd	0.58	59.74
	Prepare, prime and paint two undercoats and one finishing coat of gloss paint on metalwork				
B	General surfaces	9	Sq. yd.	0.60	5.40
C	Surfaces not exceeding 3" girth	30	Lin.yd	0.10	3.00
	Knot, prime, stop and paint two undercoats and one finishing coat of gloss paint on woodwork				
D	General surfaces	41	Sq. yd.	0.70	28.70
	EXTERNAL WORK				
	Prepare, prime and paint two coats of emulsion paint on:				
E	Fair faced blockwork	103	Sq. yd	0.58	59.74
	Prepare, prime and paint two undercoats and one finishing coat of gloss paint on metalwork				
F	General Surfaces	9	Sq. yd	0.60	5.40
G	Surfaces not exceeding 3" girth	30	Lin.yd	0.10	3.00
H	Surfaces over 3" but not exceeding 6" girth	6	Lin.yd	0.15	0.90
	Knot, prime, stop and paint two undercoats and one finishing coat of gloss paint on woodwork				
	General surfaces	32	Sq. yd	0.70	22.40
				Carried to COLLECTION	₦ 188.28

COLLECTION	₦
Page 4	1427.96
Page 5	508.22
Page 6	188.28
SUPERSTRUCTURE Carried to SUMMARY	₦ 2124.46

SUMMARY

NORMAL SOIL CONDITIONS

		Page	₦
Bill No. 2	Substructure	1	371.32
Bill No. 4	Superstructure	6	2124.46
	TOTAL - Normal Soil Conditions Carried to FORM OF TENDER		₦ 2495.78

Note: The above total is converted to a cost per square metre of floor area by dividing the gross cost by the gross floor area of the building.

CHAPTER 5

HISTORICAL COST METHOD

SOURCE, COLLECTION AND PROCESSING OF DATA:

5.01 Object of Method

The object in using the historical cost method, i.e. analysis was to try to overcome some of the drawbacks of the synthesis method. The latter results in their present form, do not reflect all changes in market conditions or changes in productivity. Market conditions are reflected in the unit rate method to the extent that it does account for the effect of supply and demand on material prices. However, it does not measure the effect of supply or demand on contractors organisations in terms of the number of new contracts being placed compared with the contractors average output. A large quantity of new work will force up prices whereas a shortage of work will bring prices down. To obtain cost data which included these factors it was necessary to analyse "all in costs" of completed buildings. Ideally, this would be an analysis of contractors accepted tenders. However, due to the wide variation in technical expertise from contractor to contractor the quality of this type of cost data would depend primarily on the expertise of the technical staff employed by each contractor. Seeley[2] says that the main source of cost information, contractors prices, is itself subject to considerable variation from contractor to contractor, district to district, and job to job and over periods of time. Skilled judgement is therefore necessary when extracting and using cost information from priced bills of quantities, obtained as a result of competitive tendering. To overcome this problem the International Development Association projects were used. The "all in" costs for these projects were prepared by professional firms of quantity surveyors in Nigeria and could all be relied upon to be reasonably accurate.

5.02 The International Development Association Programme

In 1965 an international firm of Consultant Architects and Quantity Surveyors Robert Matthew, Johnston-Marshall and Partners based in Edinburgh were commissioned by the International Development Association an associate of the World Bank to act as overall consultants for an educational expansion programme in Nigeria comprising some 220 building contracts covering new projects and or extensions to existing schools and colleges. To implement the programme they sent a team of consultants to Nigeria who investigated local systems of construction, foundation/

foundation problems, climatic condition and space requirements in Educational Institutions. From their investigations the team produced a guide to the design of educational buildings in Nigeria[15] which laid down standards for construction and space per pupil for each type of education building. It also listed areas where foundation problems could be expected. On the assumption that, generally, the climate in tropical countries is an enemy of efficiency in schools it divided the country into climatic zones and specified the comfort limits which must be achieved in each area. These limits controlled temperature, humidity and the through passage of air at various times of the day and season. Designers were required to achieve these limits by natural air-conditioning, i.e. by the use of suitable forms of construction, specified areas of fixed and adjustable ventilation and by attention to wind and sun shading. They also prepared a procedures guide which laid down methods of implementing the design proposals and controlling expenditure on the projects.[16] This guide required the quantity surveyors to provide a full cost planning service on each project. To further implement the programme local firms of Architects, Engineers and Quantity Surveyors were appointed to design and cost control the various projects in accordance with the Design and Procedures guides.

5.03 Format of Information

The consultant quantity surveyors prepared detailed cost analysis for each project. The information was presented on standard proforma shown in figs. 5.01 - .03. Fig. 5.01 is an analysis of the "All-in" cost of a completed project. Fig. 5.02 is used to analyse the "all-in" costs of each building in a project. The analysis is presented in elemental form, i.e. each of the main elements of a building such as work up to ground floor, frame, roof etc. are costed separately and added together to give the gross cost. Fig. 5.03 gives specification notes for each building. Sets of these proforma were prepared at sketch design and detail design stages. In a few cases it was also done at contract award stage and it was intended that some would be done at final account stage. However, due to the situation in the country between the years 1966 - 1970 the duration of the projects was extended beyond that originally envisaged and the procedures had to be curtailed in the interest of reducing costs.

5.04/

5.04 Source of Information

The cost data on this programme was obtained partly from the professional offices who prepared them and partly from the offices of Robert Matthew, Johnson-Marshall and Partners in Kaduna and Lagos.

5.05 Collection of Information

The detailed cost data obtained for this programme covers about 50% of the projects involved. It is contained in seven volumes which are provided in support of this thesis. Initially the information was collected by students from the Kaduna Polytechnic College in 1971 and 1972, who while on vacation employment with the Ministry of Works and Housing in Kaduna were attached to the offices of Robert Matthew, Johnson-Marshall & Partners in Kaduna and copied the information on to blank forms. Later some was collected by quantity surveying students from Ahmadu Bello University, Zaria, while on vacation employment. Later still two further box files of data were received on loan from the Lagos office of the overall consultants.

The location of the projects for which cost data was obtained are shown on the map of Nigeria in Fig. 5.04.

5.06 Processing of Information

With the historical cost method the processing was a very simple activity as all the analysis work had already been done by the consultant quantity surveyors. The results are in elemental form and expressed as "all-in" costs in Nigerian shillings per square foot of floor area. These rates are converted mathematically to "all-in" costs in Naira per metre squared of floor area. Lagos 1967 at a cost of ₦72.81 per m^2 is taken as the base location and date. All the costs per m^2 are related to this base and expressed as an index.

HISTORICAL COST ANALYSIS SHEET

1.01	Region (note 1)		NORTH
1.02	Type of School		SECONDARY
1.03	Name of School		GOVERNMENT GIRLS COLLEGE
1.04	Type		(new*/major*/minor*)
1.05	Minimum net teaching area		s.f.
1.06	Number of pupils		No.
1.07	Minimum net teaching area per pupil	(1.05 ÷ 1.06)	s.f.
1.08	Proposed net teaching area	(note 2)	s.f.
1.09	Proposed net teaching area per pupil	(108 ÷ 1.06)	
1.10	New boarding places		
1.11	Maximum pupils served per meal from new kitchen		
1.12	Total cost of buildings Phase I	(aggregate total of 2.14 column c)	£N84,434
1.13	Total cost of site preparation and external works Phase I	(note 3)	£N11,684
1.14	Total estimated cost excluding fees	(1.12 + 1.13)	£N96,118
1.15	Total value of preliminaries		£N 307
1.16	Total value of contingencies		£N 1,300
1.17	Percentage of preliminaries	(1.15 ÷ 1.14 x 100)	0.38%
1.18	Percentage of contingencies	(1.16 ÷ 1.14 x 100)	1.35%
1.19	Special costs (note 4)		
	(a) Special costs relating to buildings (elements B - O)		
	3 No. Matrons Quarters		£N 6,134
	(b) Special costs relating to site preparation and external works		
	Diversion and extension of fencing		498
	Additional drainage to pipe effluent from site		1,530
	Addition of stabilization pond including fence		4,460
			£N 6,488
1.20	Specification notes of site preparation and external works (note b)		
	Site clearance, drainage, roads and paths, external water and electrical distribution, diversion and extension of existing boundary fence and provision of stabilization pond beyond the site.		
1.21	Architect D Gillies-Moyburn		
1.22	Quantity Surveyor Widness & Trollope		
1.23	Consulting Engineers M.O.W. Kano		
1.24	Form completed by Widness & Trollope		
1.25	Date 22nd May 1970		

FIG. 5.01

HISTORICAL COST ANALYSIS SHEET

2.01	Building name or reference	DORMITORY
2.02	Type of accommodation (note 6)	D
2.03	Number of similar buildings	3
2.04	Maximum number of storeys	2
2.05	Total ground floor area (note 7)	11,890 s.f.
2.06	Aggregate of upper floor areas (note 7)	9,930 s.f.
2.07	Total floor area (2.05 + 2.06)	21,820 s.f.
2.08	Area of enclosing walls (note 8)	24,380 s.f.
2.09	Volume of building (note 9)	243,800 c.f.
2.10	Wall/floor ratio (2.08 ÷ 2.07)	1.11
2.11	Average storey height (2.09 ÷ 2.07)	10'0"
2.12	Value of contingencies (note 10)	£N 1,022
2.13	Value of preliminaries (note 10)	£N 288

2.14 Elemental analysis (note 11)

Code	Element	Element quantity a	Element unit rate shillings b = c ÷ a	Element cost £N c	Cost per s.f floor area shillings d = c ÷ 2.07
B	Work to top of ground floor.	11,890 s.f.	14.1	8,814	8.1
C	Frame				
D	Roof	15,030 s.f.	19.1	14,394	13.2
E	Upper Floors	9,930 s.f.	16.6	8,262	7.6
F	External walls	26,030 s.f.	16.6	21,552	19.7
G	Internal walls	20,810 s.f.	7.4	7,659	7.0
H	Fixtures and fittings			6,864	6.2
J	Plumbing installation	93 No.	1232.9	5,730	5.3
K	Electrical installation	330 No.	150.0	2,475	2.3
L	Gas installation	No.			
M	Air handling installation	c.f.			
N	Other services				
O	Telephone installation	No.			
	Totals			75,750	69.4

2.15	Date of tender	JANUARY 1970
2.16	Type of Tender	SELECTED
2.17	Contract starting date	MARCH 1970
2.18	Contract completion date	DECEMBER 1970
2.19	Name of Contractor	A.G. GERRARD & CO LTD
2.20	Address of Contractor	P.O. Box 125 Kaduna

Note: Items 2.15 to 2.20 are applicable only to the cost analysis of the contract sum.

FIG. 5.02

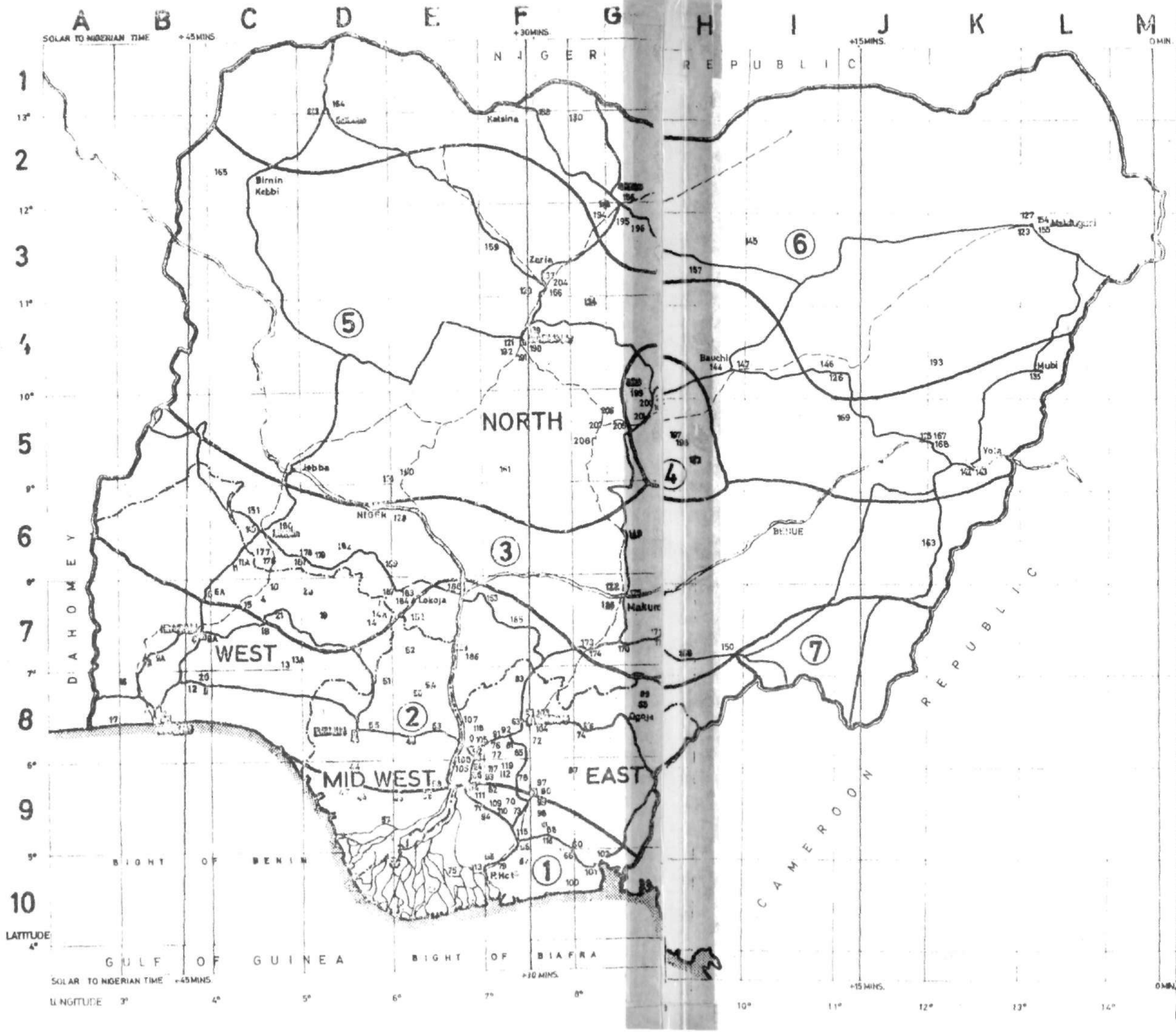
HISTORICAL COST ANALYSIS SHEET

2.23 Specification notes (note 12)

Code	Item	Description
B	Ground floor construction	6" Concrete
	Ground floor finish	1½" Granolithic
D	Roof structure	Steel and timber. Concrete slab over staircase.
	Rainwater plumbing	Asbestos
	Roof finish	Aluminium. Felt over staircase
	Ceiling beneath roof	½" Insulation board and polystyrene Render over staircases.
E	Upper floors structure	4" reinforced concrete
	Staircase structure	Reinforced concrete
	Upper floors finish	1½" Granolithic
	Ceiling beneath floors	Render
F	External walls structure	9" hollow block (9" cavity walling to Matrons)
	Windows	Louvres, concrete screens, Mosquito proofing
	External doors	Ply faced flush
	External walls(ext.finish)	Render
	External walls (int. finish)	Render
G	Internal walls structure	9" load bering on ground floor and 9" x 6" hollow
	Internal doors	Ply faced flush
	Internal walls finish	Render
H	Fixtures and fittings	Terrazzo worktops, lockers, shelvings, Cupboards
J	Cold water pipework	Galvanized
	Hot water pipework	"
	Waste pipework	"
	Soil pipework	Asbestos
	Sanitary fittings	27 W.C. - 27 L.B - 12 sink - 3 Bath - 24 showers
K	Electrical wiring	Concealed

FIG. 5.03

I. D. A. PROJECTS.
COMPUTER.
PROJECTS.



KEY

5 — Climatic Zone and number

Railways

Regional Boundary

Rivers

National Boundary

123 — Project Number

Trunk Roads

FIG. 5.04

I D A

EDUCATION PROJECT NIGERIA

ROBERT MATTHEW, JOHNSON MARSHALL & PARTNERS AND NIGERIA DEVELOPMENT CONSULTANTS

MAP OF PROJECT ITEMS AND CLIMATIC ZONES

SCALE 20 0 20 MILES

CHAPTER 6

COST DATA 1967 - 1974

6.01 Format of Data

The source, collection and processing of the cost data are described in Chapters 3, 4 and 5.

The total cost of each building is expressed in terms of its cost per square metre of floor area and is listed according to location and date. The data is then converted to indices using a suitable base in each case. Each Index is followed by a statistical analysis to check its reliability for use in forecasting future costs. The characteristics of the results are summarised and described in Chapter 7.

6.02 I.D.A. Historical Location Cost Data: 1967

The location cost and the location index for all buildings for 1967 are shown in Fig. 6.01 and the statistical analysis is shown in Fig. 6.02 and a histogram showing an overprinted distribution curve is shown in Fig. 6.03. The significant statistical measure is the coefficient of variation (c.var). This is the standard deviation expressed as a percentage of the mean. Assuming the population is normally distributed a coefficient of variation of less than 10% is necessary for a 95% certainty in any prediction. This calculation is described in Chapter 7. For 1967 Vs = 14.9863. This is well above 10% but is one of the best results achieved for historical cost data. The ranges are also found to be very high. In 1967 it was 71. The 1967 data is expressed in terms of costs of all buildings as the sample was not large enough to allow for further stratification.

Where there are a number of prices for the same type of building in the same location this is due to differences in design solutions from different architects.

All Buildings 1967

(i) Location Costs M^2/Floor area

(ii) Location Index — Lagos = 100

LOCATION	COST N/M^2	INDEX	LOCATION	COST N/M^2	INDEX
Classrooms					
1. Mubi	69.62	96	15. Gombe	79.33	109
2. Gombe	72.29	99	16. Gombe	78.79	108
3. Maiduguri	70.24	96	17. Maiduguri	64.85	89
Administration Block			18. Maiduguri	67.35	93
4. Mubi	78.84	108	19. Maiduguri	66.75	92
5. Mubi	79.98	110	Schools		
6. Mubi	72.13	100	20. Gombe	78.62	108
7. Gombe	85.67	118	21. Azare	86.36	92
Dormitories			22. Yola	94.27	129
8. Mubi	62.63	86	23. Kaduna	61.49	84
9. Mubi	53.64	74	24. Mubi	101.04	139
10. Maiduguri	49.81	68	25. Maiduguri	75.67	104
Assembly Halls			26. Lagos	72.81	100
11. Mubi	81.11	111			
12. Mubi	77.26	106			
13. Gombe	75.18	103			
14. Maiduguri	77.97	107			

FIG. 6.01

Statistical Analysis A.B. 1967

HISTOGRAM

OFFSET= 0.5

CELL WIDTH = 12

DATA

CONSTANT SUBTRACTED 70

26.0000
29.0000
26.0000
38.0000
40.0000
30.0000
48.0000
16.0000
4.0000
-2.0000
41.0000
36.0000
33.0000
37.0000
39.0000
38.0000
19.0000
23.0000
22.0000
38.0000
22.0000
59.0000
14.0000
69.0000
34.0000
30.0000

N = 26
MEAN = 101.1154
STD. DEV = 15.1534
SKEWNESS = 0.1717
KURTOSIS = 3.4256
XMIN = -2.0000
XMAX = 69.0000
RANGE = 71.0000

C.VAR = 14.9863

CELL #	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-5.5000	2	7.69231
2	6.5000	2	7.69231
3	18.5000	9	34.61538
4	30.5000	10	38.46154
5	42.5000	1	3.84615
6	54.5000	1	3.84615
7	66.5000	1	3.84615

Fig. 6.02

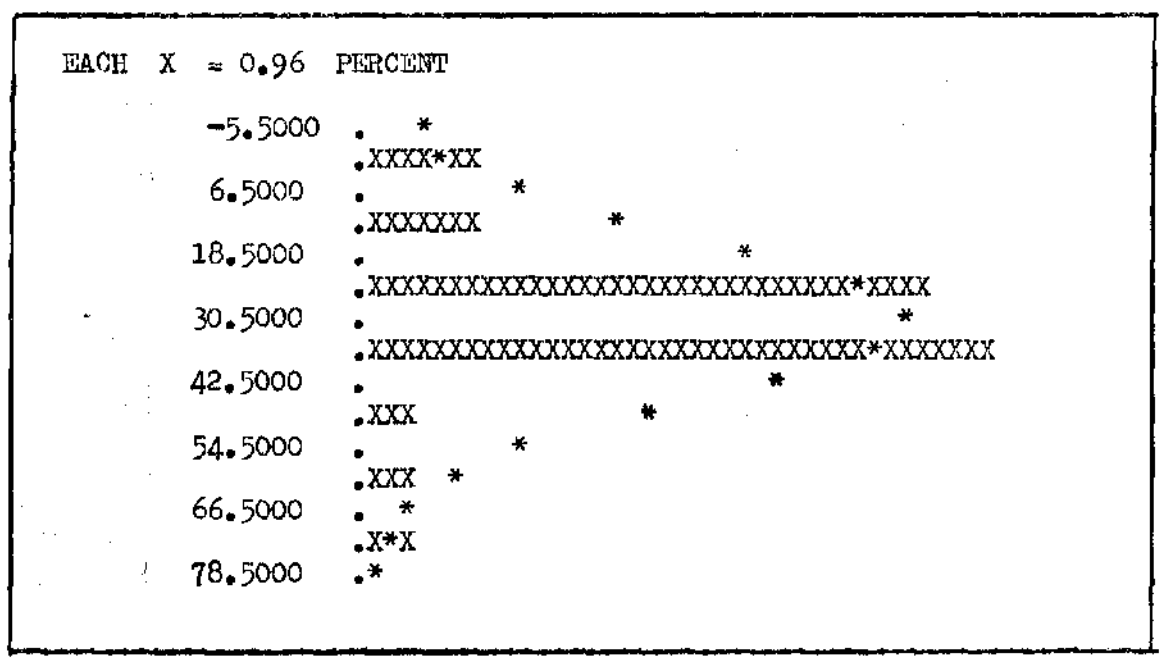

EACH X = 0.96 PERCENT
-5.5000
6.5000
18.5000
30.5000
42.5000
54.5000
66.5000
78.5000

FIG. 6.03

6.03 I.D.A. Historical Location Cost Data: 1968

The location costs per square metre of floor area, the location indices and the statistical analysis for 1968 are shown in Figs. 6.04 to 6.19. The samples available for 1968 are very much larger than those for 1967. As a result separate indices are provided for classrooms, administration blocks, assembly halls, and housing. These are then collected and expressed as indices for secondary schools and finally all schools. The purpose of this stratification is to see if by using an index which compared the costs of the same type of building or the same type of school, the results would be better than those obtained from an index comparing all buildings irrespective of type or function. The results were in fact better. For all schools Vs = 40; secondary schools Vs=30; housing Vs = 15; assembly Halls Vs = 21; administration blocks Vs = 24 and classrooms Vs = 22. These figures are considerably in excess of the 10% limit. Nevertheless stratification seems to improve the results and as Wrobel[14] says it supports the common sense viewpoint and reinforces the dictum that like must be compared with like. The ranges continue to be very high. From 26 for housing to 159 for all schools.

Classrooms 1968
(i) Location Costs M^2/Floor Area
(ii) Location Index.

Lagos = 100

	LOCATION	COST N/M^2	INDEX
1.	Makurdi	42.41	91
2.	Lafia	45.35	97
3.	Makurdi	45.35	97
4.	Makurdi	41.66	89
5.	Lafia	45.21	97
6.	Lagos	46.82	100
7.	Zaria	67.02	143
8.	Kano	62.11	133
9.	Ilorin	55.83	119
10.	Ilorin	59.20	126
11.	Bauchi	68.65	147
12.	Maiduguri	66.80	143
13.	Yola	74.87	160
14.	Sapele	48.63	104
15.	Sapele	37.03	79
16.	Sapele	45.67	98

FIG. 6.04

STATISTICAL ANALYSIS CLASSROOMS 1968

HISTOGRAM

OFFSET = 0.5

CELL WIDTH = 13

DATA

CONSTANT SUBTRACTED 78

13.0000
19.0000
19.0000
11.0000
19.0000
22.0000
65.0000
55.0000
41.0000
48.0000
69.0000
65.0000
82.0000
26.0000
1.0000
20.0000

N = 16
MEAN = 113.9375
STD. DEV. = 24.7857
SKEWNESS = 0. 4074
KURTOSIS = 1.6213
XMIN = 1.0000
XMAX = 82.0000
RANGE = 81.0000

C.VAR = 21.7537

CELL #	LOWER LIMIT	NO.OF OBS	% RELATIVE FREQ
1	-6.0000	1	6.25000
2	7.0000	5	31.25000
3	20.0000	3	18.75000
4	33.0000	1	6.25000
5	46.0000	2	12.50000
6	59.0000	3	18.75000
7	72.0000	1	6.25000

EACH X = 0.78 PERCENT

```
- 6.0000.      *
        .XXXXXXXX  *
  7.0000.              *
        .XXXXXXXXXXXXXXXXXX*XXXXXXXXXXXXXXXXXXXX
 20.0000.                    *
        .XXXXXXXXXXXXXXXXXXXXXXXX *
 33.0000.                        *
        .XXXXXXXX                *
 46.0000.                      *
        .XXXXXXXXXXXXXXX     *
 59.0000.                 *
        .XXXXXXXXXXXXX*XXXXXXXXXX
 72.0000.          *
        .XXXXXX*X
 85.0000.     *
```

Administration Blocks 1968

(i) Location Costs M^2/Floor Area — Lagos = 100

(ii) Location Index

Location		Cost N/M^2	Index
1.	Makurdi	51.24	81
2.	Lafia	51.66	81
3.	Makurdi	39.18	62
4.	Lafia	50.48	80
5.	Maiduguri	63.40	100
6.	Azare	82.90	131
7.	Yola	77.16	122
8.	Maiduguri	67.42	106
9.	Maiduguri	72.31	114
10.	Azare	84.20	133
11.	Zaria	93.89	148
12.	Ilorin	61.00	96
13.	Sokoto	83.86	132
14.	Lagos	63.40	100

FIG. 6.06

STATISTICAL ANALYSIS AD. BLOCKS 1968

OFFSET = 0.5
CELL WIDTH = 14
DATA
CONSTANT SUBTRACED 61

20.0000
20.0000
1.0000
19.0000
39.0000
70.0000
61.0000
45.0000
53.0000
72.0000
87.0000
35.0000
71.0000
39.0000

N	=	14	
MEAN	=	106.1429	
STD. DEV.	=		25.0349
SKEWNESS	=		-0.0335
KURTOSIS	=		1.7388
XMIN	=	1.0000	
XMAX	=	87.0000	
RANGE	=	86.0000	

CVAR = 23.5861

CELL #	LOWER LIMIT	No.OF OBS	% RELATIVE FREQ
1	-6.5000	1	7.14286
2	7.5000	3	21.42857
3	21.5000	1	7.14286
4	35.5000	3	21.42857
5	49.5000	2	14.28571
6	63.5000	3	21.42857
7	77.5000	1	7.14286

EACH X = 0.54 PERCENT

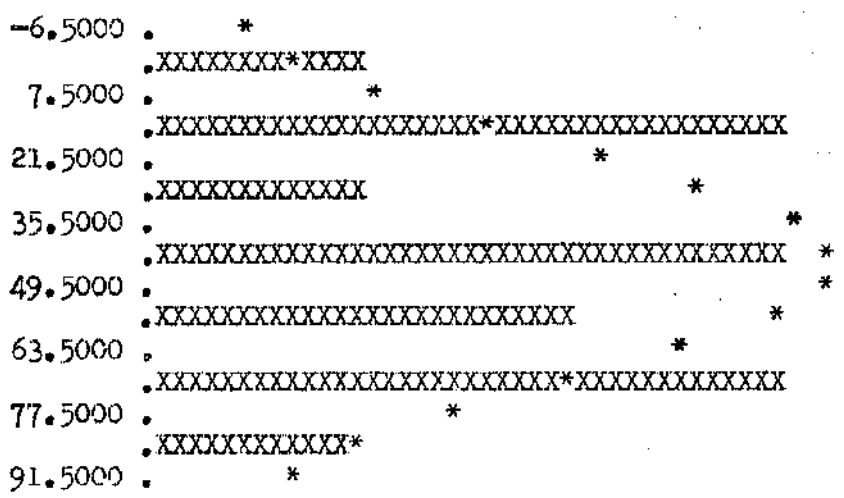


FIG. 6.07

Assembly Halls 1968

(i) Location Costs M^2/Floor Area

(ii) Location Index — Lagos = 100

	LOCATION	COST N/M^2	INDEX
1.	Makurdi	102.47	143
2.	Lafia	57.08	79
3.	Makurdi	65.02	91
4.	Lagos	71.80	100
5.	Zaria	69.65	97
6.	Kano	71.58	100
7.	Ilorin	59.84	83
8.	Ilorin	99.89	139
9.	Bauchi	68.06	95
10.	Azare	55.01	77
11.	Yola	80.17	112
12.	Bauchi	77.02	107
13.	Bauchi	68.67	96
14.	Azare	51.45	72
15.	Sokoto	89.30	124

FIG. 6.08

STATISTICAL ANALYSIS A. HALLS 1968

HISTOGRAM

OFFSET = 0.5
CELL WIDTH = 12
DATA
CONSTANT SUBTRACTED 71

72.0000
8.0000
20.0000
29.0000
26.0000
29.0000
12.0000
68.0000
24.0000
6.0000
41.0000
36.0000
25.0000
1.0000
53.0000

N = 15
MEAN = 101.0000
STD. DEV. = 21.2098
SKEWNESS = 0.6049
KURTOSIS = 2.2675
XMIN = 1.0000
XMAX = 72.0000
RANGE = 71.0000

C.VAR = 20.9998

CELL #	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-5.5000	2	13.33333
2	6.5000	2	13.33333
3	18.5000	6	40.00000
4	30.5000	2	13.33333
5	42.5000	1	6.66667
6	54.5000	0	0.00000
7	66.5000	2	13.33333

EACH X = 1.00 PERCENT

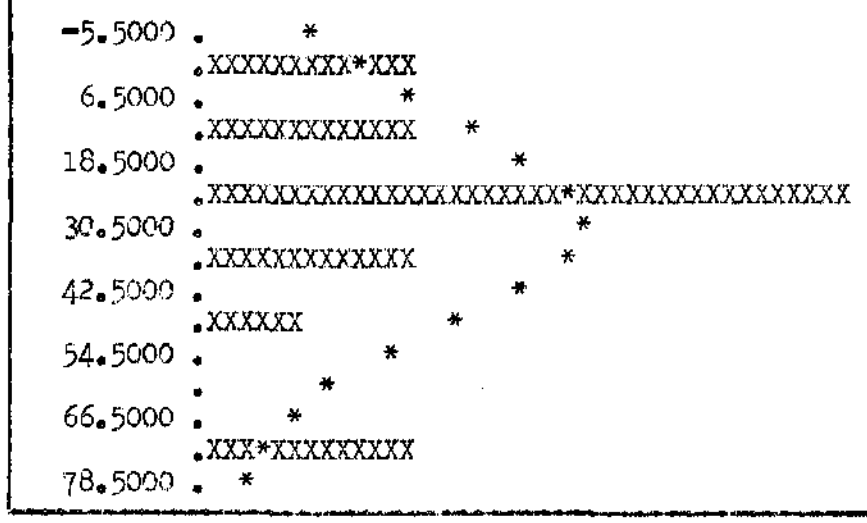


FIG. 6.09

Housing 1968

(i) Location Costs M^2/Floor Area.

(ii) Location Index — Lagos = 100

LOCATION	COST N/M^2	INDEX
1. Makurdi	57.05	111
2. Makurdi	59.09	115
3. Maiduguri	75.78	147
4. Bauchi	72.13	140
5. Azare	65.07	126
6. Yola	76.69	149
7. Bauchi	67.74	132
8. Yola	75.95	148
9. Oyo	50.59	98
10. Owo	50.56	98
11. Lagos	51.44	100
12. Ilorin	56.35	110
13. Ilorin	65.87	128
14. Sapele	57.63	112
15. Sapele	55.00	107

FIG. 6.10

STATISTICAL ANALYSIS HOUSING 1968

HISTOGRAM
OFFSET = 0.5
CELL WIDTH = 9
DATA
CONSTANT SUBTRACTED 97

14.0000
18.0000
50.0000
43.0000
29.0000
52.0000
35.0000
51.0000
1.0000
1.0000
3.0000
13.0000
31.0000
15.0000
10.0000

N = 15
MEAN = 121.4000
STD. DEV. = 18.4693
SKEWNESS = 0.2383
KURTOSIS = 1.4527
XMIN = 1.0000
XMAX = 52.0000
RANGE = 51.0000

C.VAR = 15.2136

CELL #	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-4.0000	3	20.00000
2	5.0000	2	13.33333
3	14.0000	3	20.00000
4	23.0000	2	13.33333
5	32.0000	1	6.66667
6	41.0000	1	6.66667
7	50.0000	3	20.00000

EACH X = 0.50 PERCENT

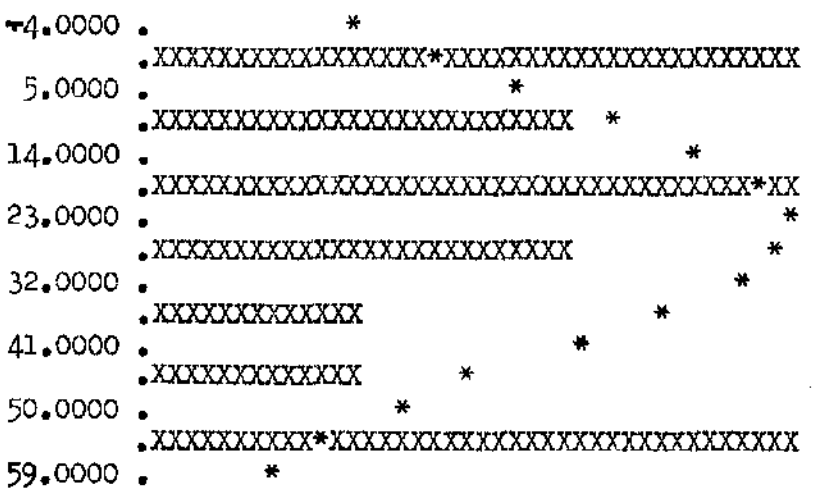


FIG. 6.11

Secondary Schools 1968 (i) Location Costs M^2/Floor Area
(ii) Location Index Lagos = 100

	LOCATION	COST N/M^2	INDEX
1.	Lafia	106.42	131
2.	Katsina - Ala	63.96	79
3.	Katsina - Ala	70.59	87
4.	Makurdi	85.77	105
5.	Bauchi	76.25	94
6.	Gombe	77.72	95
7.	Gombe	78.62	97
8.	Azare	83.46	103
9.	Azare	86.36	106
10.	Bauchi	83.48	103
11.	Yola	87.81	108
12.	Yola	94.27	116
13.	Yola	90.80	112
14.	Kano	57.77	71
15.	Ilorin	63.67	78
16.	Kaduna	61.49	76
17.	Zaria	46.30	57
18.	Zaria	60.29	74
19.	Lagos	81.40	100
20.	Oyo	40.16	49
21.	Abeokuta	99.14	122
22.	Abeokuta	45.86	56
23.	Ogbo	99.14	122
24.	Shagamu	99.14	122
25.	Ondo	99.14	122

FIG. 6.12

STATISTICAL ANALYSIS SEC. SCHOOLS 1968

HISTOGRAM

OFFSET = 0.5
CELL WIDTH = 14
DATA
CONSTANT SUBTRACTED 46

85.0000
33.0000
41.0000
59.0000
48.0000
49.0000
51.0000
57.0000
60.0000
57.0000
62.0000
70.0000
66.0000
25.0000
32.0000
30.0000
11.0000
28.0000
54.0000
3.0000
76.0000
10.0000
76.0000
76.0000
76.0000
39.0000
1.0000
10.0000
13.0000
8.0000
10.0000
14.0000
22.0000
35.0000
16.0000
51.0000
22.0000
13.0000
13.0000
13.0000
17.0000
13.0000

FIG. 6.14

N = 42
MEAN = 82.7857
STD. DEV. = 24.6414
SKEWNESS = 0.3133
KURTOSIS = 1.6944
XMIN = 1.0000
XMAX = 85.0000
RANGE = 84.0000

C.VAR = 29.7652

CELL #	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-6.5000	2	4.76190
2	7.5000	13	30.95238
3	21.5000	8	19.04762
4	35.5000	4	9.52381
5	49.5000	8	19.04762
6	63.5000	6	14.28571
7	77.5000	1	2.38095

EACH X = 0.77 PERCENT

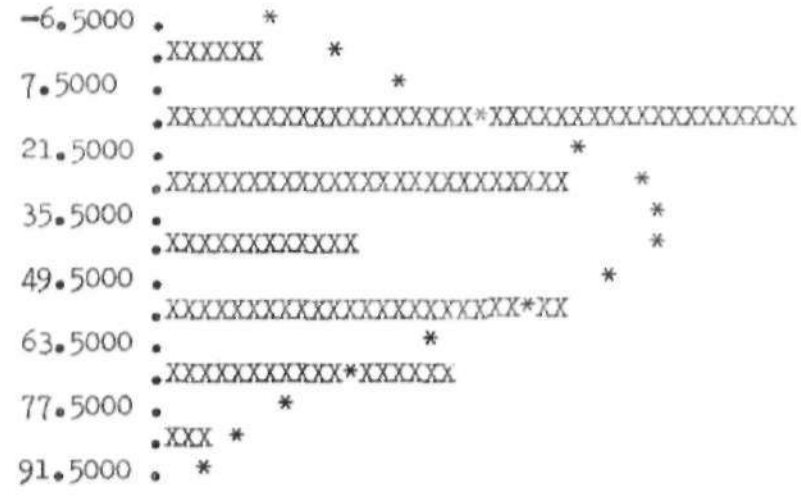


FIG. 6.15

All Schools 1968 — Lagos = 100

(i) Location Costs M^2/Floor Area

(ii) Location Index

LOCATION		COST N/M^2	INDEX
1.	Lafia	106.42	131
2.	Katsina Ala	70.59	87
3.	Makurdi	85.77	105
4.	Pankshin	83.98	103
5.	Bauchi	76.25	94
6.	Gombe	77.72	95
7.	Azare	162.46	200
8.	Bauchi	83.48	103
9.	Yola	87.81	108
10.	Yola	90.80	112
11.	Mubi	92.80	114
12.	Maiduguri	78.55	96
13.	Gombe	87.17	107
14.	Numan	83.23	102
15.	Maiduguri	73.48	90
16.	Kano	57.77	71
17.	Ilorin	63.37	78
18.	Pategi	100.04	123
19.	Zaria	60.29	74
20.	Soba	86.59	106
21.	Mashi	64.45	79
22.	Zaria	88.57	109
23.	Lagos	81.40	100
24.	Ijebu Ode	57.13	70
25.	Oyo	58.70	72
26.	Oyo	40.16	49
27.	Owo	58.70	72
28.	Ibadan	33.17	41
29.	Ibadan	33.17	41
30.	Abeckuta	99.14	122

FIG. 6.16

All Schools 1968 (contd.)

LOCATION		COST N/M^2	INDEX
31.	Abeckuta	33.17	41
32.	Ogbomosho	99.14	122
33.	Ogbomosho	33.17	41
34.	Shagamu	99.14	122
35.	Ondo	99.14	122
36.	Ondo	33.17	41
37.	Ikare	33.17	41
38.	Ilaro	33.17	41
39.	Ife	33.17	41
40.	Ado-Ekiti	33.17	41
41.	Ijebu-Ode	33.17	41
42.	Ilesha	33.17	41
43.	Iddo-Ekiti	33.17	41
44.	Sokoto	97.73	120
45.	Bida	76.52	94
46.	Sapele	61.76	76
47.	Benin	69.08	85
48.	Agbor	38.41	47
49.	Effurum	48.41	59
50.	Emeror	45.48	56
51.	Irrua	55.70	68
52.	Sabongida-Ora	66.26	81
53.	Igara	79.03	97
54.	Ubulu - Uka	55.70	68
55.	Uromi	48.41	59
56.	Benin	48.41	59
57.	Ozoro	48.41	59
58.	Bomadi	51.45	63
59.	Ashaka	48.41	59

FIG. 6.17

STATISTICAL ANALYSIS ALL SCHOOLS 1968

HISTOGRAM
OFFSET = 0.5
CELL WIDTH = 15
DATA
CONSTANT SUBTRACTED 40

91.0000
47.0000
65.0000
63.0000
54.0000
55.0000
160.0000
63.0000
68.0000
72.0000
74.0000
56.0000
67.0000
62.0000
50.0000
31.0000
38.0000
83.0000
34.0000
66.0000
39.0000
69.0000
60.0000
30.0000
32.0000
9.0000
32.0000
1.0000
1.0000
82.0000
1.0000
82.0000
1.0000
82.0000
82.0000
1.0000
1.0000
1.0000
1.0000
1.0000
1.0000
1.0000
1.0000
1.0000
80.0000
54.0000
36.0000
45.0000
7.0000
19.0000
16.0000
28.0000
41.0000
57.0000
28.0000
19.0000
19.0000

FIG 6.18

19.0000
23.0000
19.0000

N = 59
MEAN = 81.0169
STD. DEV= 32.3198
SKEWNESS= 0.7531
KURTOSIS= 4.0967
XMIN = 1.0000
XMAX = 160.0000
RANGE = 159.0000

C.VAR = 39.8926

CELL #	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-7.0000	13	22.03390
2	8.0000	7	11.86441
3	23.0000	9	15.25424
4	38.0000	6	10.16949
5	53.0000	12	20.33898
6	68.0000	9	15.25424
7	83.0000	2	3.38983
8	98.0000	0	0.00000
9	113.0000	0	0.00000
10	128.0000	0	0.00000
11	143.0000	0	0.00000
12	158.0000	1	1.69492

EACH X = 0.55 PERCENT

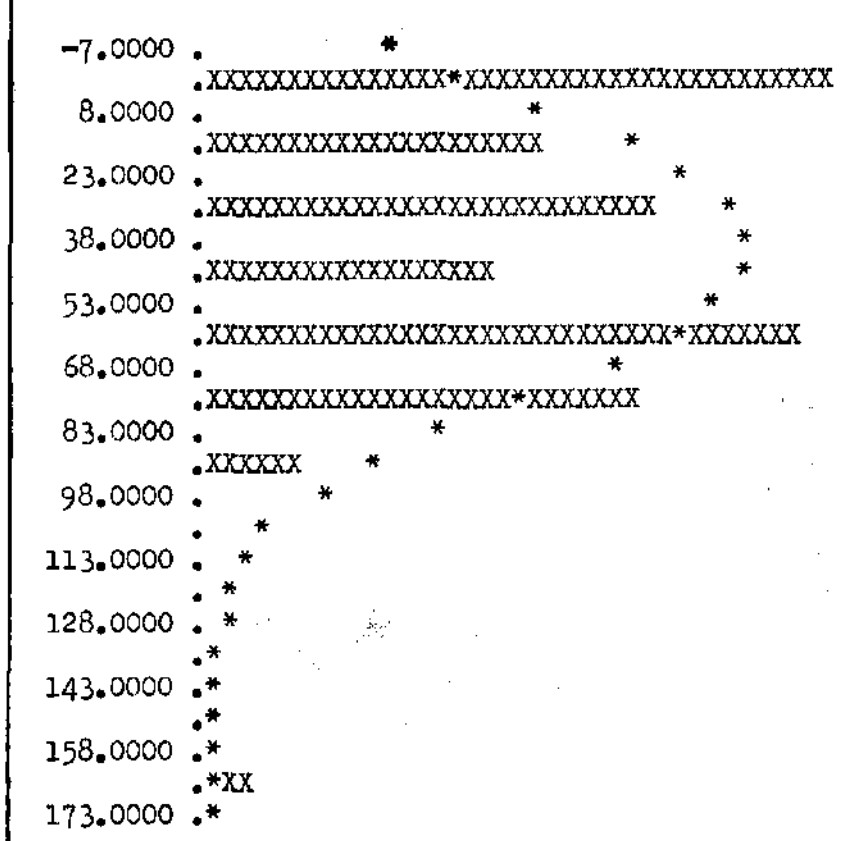


FIG. 6.19

6.04 I.D.A. Historical Location Cost Data 1969

The location costs per square metre of floor area, the location indices and the statistical analysis for 1969 are shown in Figs. 6.20 to 6.32. Separate indices are provided for classrooms, administration blocks, assembly halls, housing and all schools. The values of v range from 9% to 26%.

6.05 I.D.A. Historical Location Cost Data 1970

The location costs per square metre of floor area, the location index and statistical analysis for 1970 are shown in Figs. 6.33 and 6.34. The sample for 1970 was too small to stratify. The value of v was 24%.

6.06 Unit Rate Data: 1972, 1973 and 1974

The location costs per square metre of floor area, the location indices and the statistical analysis are shown in Figs. 6.35 to 6.39. The statistical results are very good with values of v of 4% and 5%.

6.07 Time Scales

The time scales are shown in fig. 6.40

CLASSROOMS 1969 Lagos = 100

(i) Location Costs M^2/Floor area

(ii) Location Index

LOCATION	COST N/M^2	INDEX
1. Makurdi	47.20	106
2. Makurdi	48.33	109
3. Zaria	64.10	144
4. Zaria	60.90	137
5. Sabongida - Ora	41.70	94
6. Benin	49.51	111
7. Sabongida - Ora	44.46	100
8. Igara	48.44	109
9. Igara	53.82	121
10. Kano	59.74	134
11. Lagos	44.46	100
12. Ijebu - Ode	47.72	107
13. Ijebu - Ode	63.70	143
14. Ilorin	53.37	120
15. Okene	61.24	138
16. Okene	61.47	138
17. Gombe	57.52	152

FIG. 6.20

STATISTICAL ANALYSIS CLASSROOMS 1969

HISTOGRAM
OFFSET = 0.5
CELL WIDTH = 9
DATA
CONSTANT SUBTRACTED 93

13.0000
16.0000
51.0000
44.0000
1.0000
18.0000
7.0000
16.0000
28.0000
41.0000
7.0000
50.0000
14.0000
27.0000
45.0000
45.0000
59.0000

N =	17
MEAN =	121.3529
STD. DEV =	18.3642
SKEWNESS =	0.1352
KURTOSIS =	1.4149
XMIN =	1.0000
XMAX =	59.0000
RANGE =	58.0000
C.VAR =	15.1329

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-4.0000	1	5.88235
2	5.0000	3	17.64706
3	14.0000	4	23.52941
4	23.0000	2	11.76471
5	32.0000	0	0.00000
6	41.0000	4	23.52941
7	50.0000	2	11.76471
8	59.0000	1	5.88235

FIG. 6.21

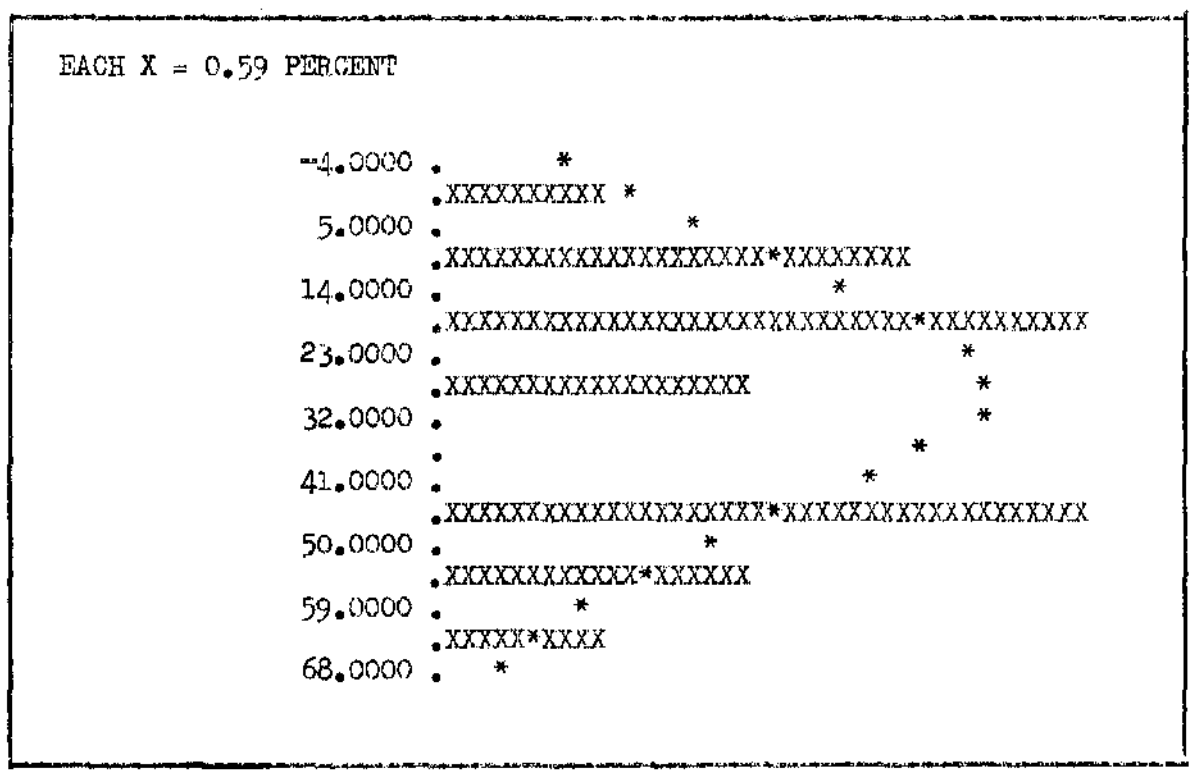

EACH X = 0.59 PERCENT
-4.0000
5.0000
14.0000
23.0000
32.0000
41.0000
50.0000
59.0000
68.0000

FIG. 6.22

STATISTICAL ANALYSIS AD. BLOCKS 1969

HISTOGRAM
OFFSET = 0.5
CELL WIDTH = 13
DATA
CONSTANT SUBTRACTED 77

1.0000
9.0000
45.0000
63.0000
64.0000
61.0000
71.0000
82.0000
58.0000
23.0000
25.0000
18.0000
65.0000

N = 13
MEAN = 122.0000
STD. DEV. = 26.4575
SKEWNESS = -0.3113
KURTOSIS = 1.4402
XMIN = 1.0000
XMAX = 82.0000
RANGE = 81.0000

C.VAR = 21.6865

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-6.0000	1	7.69231
2	7.0000	2	15.38462
3	20.0000	2	15.38462
4	33.0000	1	7.69231
5	46.0000	1	7.69231
6	59.0000	5	38.46154
7	72.0000	1	7.69231

EACH X = 0.96 PERCENT

```
-6.0000 .   *
        .XXXXX*X
 7.0000 .      *
        .XXXXXXXXXX*XXXX
20.0000 .           *
        .XXXXXXXXXXXXXX *
33.0000 .                *
        .XXXXXXX           *
46.0000 .                  *
        .XXXXXXX           *
59.0000 .                *
        .XXXXXXXXXXXXXXX*XXXXXXXXXXXXXXXXXXXXXXX
72.0000 .          *
        .XXXXXXX   *
85.0000 .      *
```

FIG. 6.24

Assembly Halls 1969 — Lagos = 100

(i) Location Costs M^2/Floor Area

(ii) Location Index

LOCATION	COST N/M^2	INDEX
1. Makurdi	73.26	109
2. Katsina Ala	60.96	91
3. Katsina Ala	62.75	94
4. Katsina Ala	74.38	111
5. Azare	54.98	82
6. Gombe	75.85	113
7. Zaria	75.99	113
8. Zaria	69.47	104
9. Sokoto	68.58	102
10. Kano	72.28	108
11. Lagos	67.03	100
12. Ilorin	68.16	102
13. Dekina	71.28	106

FIG. 6.25

STATISTICAL ANALYSIS ASS. HALLS 1969

HISTOGRAM
OFFSET = 0.5
CELL WIDTH = 5
DATA
CONSTANT SUBTRACTED 81

28.0000
10.0000
13.0000
1.0000
32.0000
32.0000
23.0000
21.0000
27.0000
19.0000
21.0000
30.0000

N = 13
MEAN = 103.0769
STD. DEV = 9.4292
SKEWNESS = -0.7916
KURTOSIS = 2.4774
XMIN = 1.0000
XMAX = 32.0000
RANGE = 31.0000

C.VAR. = 9.1478

CELL #	LOWER LIMIT	NO. of OBS	%RELATIVE FREQ
1	-2.0000	1	7.69231
2	3.0000	0	0.00000
3	8.0000	1	7.69231
4	13.0000	1	7.69231
5	18.0000	3	23.07692
6	23.0000	2	15.38462
7	28.0000	5	38.46154

EACH X = 0.96 PERCENT

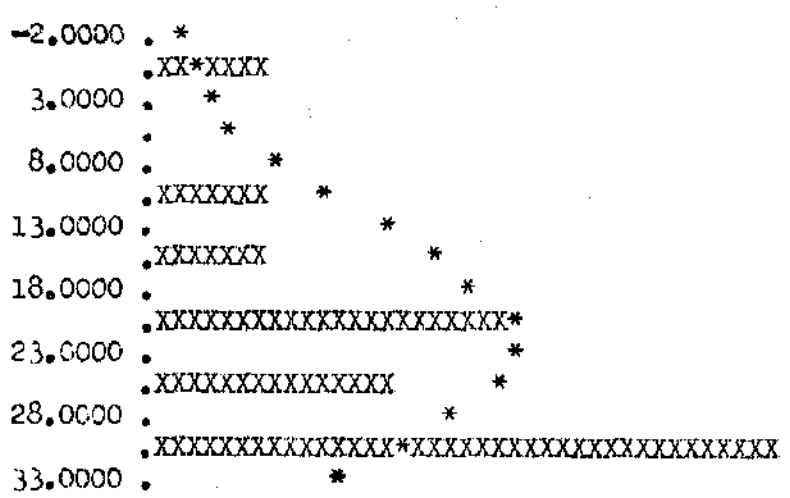


FIG. 6.26

Housing 1969

(i) Location Costs M^2/Floor Area Lagos = 100

(ii) Location Index

	LOCATION	COST N/M^2	INDEX
1.	Makurdi	60.23	119
2.	Makurdi	64.68	127
3.	Azare	65.14	129
4.	Gombe	59.26	117
5.	Zaria	69.21	137
6.	Zaria	68.08	135
7.	Kano	67.31	133
8.	Kano	54.14	107
9.	Lagos	53.27	105
10.	Lagos	50.60	100
11.	Owo	45.81	91
12.	Oyo	45.47	90

FIG. 6.27

STATISTICAL ANALYSIS HOUSING 1969

HISTOGRAM
OFFSET = 0.5
CELL WIDTH = 8
DATA
CONSTANT SUBTRACTED 89

30.0000
38.0000
40.0000
28.0000
48.0000
46.0000
44.0000
18.0000
16.0000
11.0000
2.0000
1.0000

N =	14
MEAN =	115.8333
STD.DEV =	16.9214
SKEWNESS =	-0.2269
KURTOSIS =	1.3992
XMIN =	1.0000
XMAX =	48.0000
RANGE =	47.0000
C.VAR =	14.6084

CELL #	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-3.5000	2	16.66667
2	4.5000	1	8.33333
3	12.5000	2	16.66667
4	20.5000	1	8.33333
5	28.5000	1	8.33333
6	36.5000	3	25.00000
7	44.5000	2	16.66667

EACH X = 0.63 PERCENT

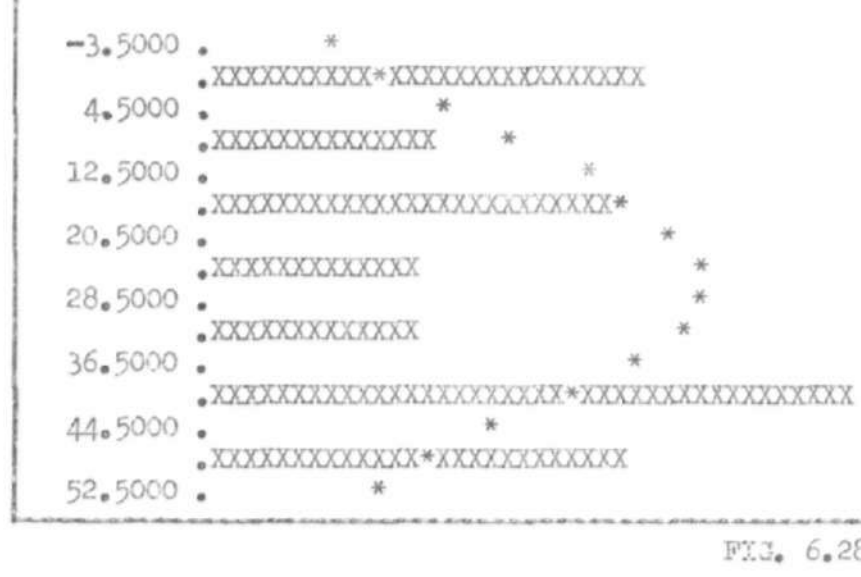


FIG. 6.28

All Schools 1969

(i) Location Costs M^2/Floor Area

(ii) Location Index

	LOCATION	COST N/M^2	INDEX
1.	Katsina - Ala	63.96	80
2.	Pankshin	84.14	105
3.	Makurdi	59.58	75
4.	Azare	83.46	105
5.	Zaria	46.30	58
6.	Moshi	67.52	85
7.	Lagos	79.81	100
8.	Sapele	78.40	98
9.	Agbor	45.57	57
10.	Effurun	44.24	55
11.	Emeror	48.45	61
12.	Irrua	62.88	79
13.	Sabongida-Ora	50.10	63
14.	Igara	44.73	56
15.	Ubula - Uku	62.88	79
16.	Uromi	42.28	53
17.	Benin	42.63	53
18.	Ozoro	42.28	53
19.	Bomadi	42.63	53
20.	Ashaka	43.09	54
21.	Sokoto	83.39	104
22.	Bida	87.90	110
23.	Ijebu-Ode	58.30	73
24.	Oyo	36.28	45
25.	Owo	61.13	77
26.	Ibadan	47.27	59
27.	Ibadan	46.80	59
28.	Abeokuta	45.86	57
29.	Abeokuta	46.80	59
30.	Ogbomosho	48.98	61

FIG. 6.29

All Schools 1969 (contd.)

	LOCATION	COST N/M^2	INDEX
31.	Ogbomosho	50.33	63
32.	Ondo	47.01	59
33.	Ondo	47.98	60
34.	Akure	50.17	63
35.	Ikare	51.45	64
36.	Ilaro	46.80	59
37.	Ile - Ife	46.80	59
38.	Ado-Ekiti	50.33	63
39.	Ijebu - Ode	46.80	59
40.	Ilesha	50.33	63
41.	Iddo - Ekiti	50.33	63
42.	Pategi	58.23	73
43.	Ida	95.20	119
44.	Ilorin	64.66	81
45.	Okene	69.65	88
46.	Dekina	76.17	95

FIG. 6.30

STATISTICAL ANALYSIS ALL SCHOOLS 1969

HISTOGRAM
OFFSET = 0.5
CELL WIDTH = 12
DATA
CONSTANT SUBTRACTED 44

36.0000
61.0000
31.0000
61.0000
14.0000
41.0000
51.0000
56.0000
54.0000
13.0000
17.0000
35.0000
19.0000
12.0000
35.0000
9.0000
9.0000
9.0000
9.0000
10.0000
60.0000
66.0000
29.0000
1.0000
33.0000
15.0000
15.0000
13.0000
15.0000
17.0000
19.0000
15.0000
16.0000
19.0000
20.0000
15.0000
15.0000
19.0000
15.0000
19.0000
19.0000
29.0000
75.0000
37.0000
43.0000
51.0000

FIG. 6.31

N = 46
MEAN = 71.6522
STD. DEV = 18.5942
SKEWNESS = 0.8788
KURTOSIS = 2.5676
XMIN = 1.0000
XMAX = 75.0000
RANGE = 74.0000

C.VAR = 25.9506

CELL #	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-5.5000	1	2.17391
2	6.5000	19	41.30435
3	18.5000	9	19.56522
4	30.5000	7	15.21739
5	42.5000	4	8.69565
6	54.5000	5	10.86957
7	66.5000	1	2.17391

EACH x = 1.03 PERCENT

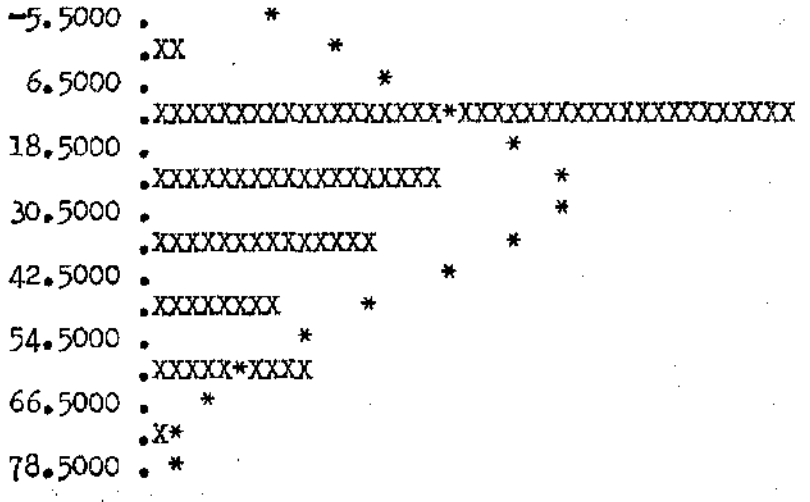


FIG. 6.32

All Buildings 1970

(i) Location Costs M^2/Floor Area — Lagos = 100

(ii) Location Index

	LOCATION	COST N/M^2	INDEX
1.	Lagos	47.15	100
2.	Ilorin	58.07	123
3.	Lagos	39.85	85
4.	Lagos	40.41	86
5.	Lagos	45.49	96
6.	Lagos	Nil	Nil
7.	Ilorin	64.12	136
8.	Lagos	51.65	110
9.	Lagos	53.51	113
10.	Lagos	52.74	112
11.	Yaba	70.80	150
12.	Igobi	46.80	99
13.	Badagry	46.80	99
14.	Lagos	90.09	191
15.	Makurdi	60.22	128
16.	Ilorin	69.24	147

FIG. 6.33

STATISTICAL ANALYSIS ALL BUILDS. 1970

HISTOGRAM
OFFSET = 0.5
CELL WIDTH = 18
DATA
CONSTANT SUBTRACTED 84

16.0000
39.0000
1.0000
2.0000
12.0000
52.0000
26.0000
29.0000
28.0000
66.0000
15.0000
107.0000
44.0000
63.0000

N = 15
MEAN = 118.3333
STD. DEV.= 28.5474
SKEWNESS = 0.9799
KURTOSIS = 3.2770
XMIN = 1.0000
XMAX = 107.0000
RANGE = 106.0000

C.VAR = 24.1245

CELL #	LOWER LIMIT	NO.OF OBS	% RELATIVE FREQ
1	-8.5000	2	13.33333
2	9.5000	5	33.33333
3	27.5000	4	26.66667
4	45.5000	2	13.33333
5	63.5000	1	6.66667
6	81.5000	0	0.00000
7	99.5000	1	6.66667

EACH X = 0.83 PERCENT

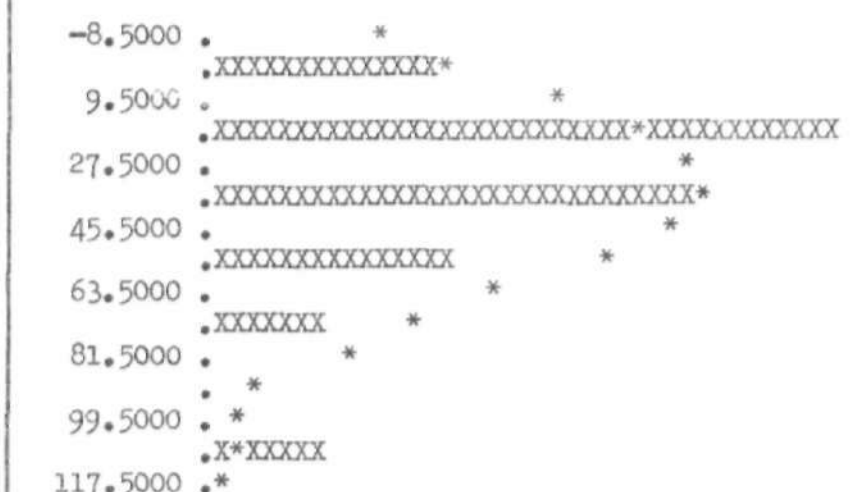


FIG. 6.34

Classrooms 1972 - 1974

	LOCATION	RATE PER M^2/FLOOR AREA		
		1972	1973	1974
		₦	₦	₦
1.	Lagos	33.51	37.51	42.02
2.	Ibadan	31.74	38.30	-
3.	Ilorin	33.16	37.61	38.24
4.	Kaduna	33.55	38.72	41.13
5.	Benin	33.88	38.34	45.46
6.	Emugu	33.81	40.51	43.34
7.	Maiduguri	33.91	38.10	44.00
8.	Sokoto	37.65	42.32	45.52
9.	Kano	34.00	38.70	44.50
10.	Jos	34.71	38.09	-
11.	Calabar	-	-	42.64

FIG. 6.35

Classrooms 1972 - 1974

LOCATION INDICES

	LOCATION	INDEX 1972	1973	1974
1.	Lagos	100	100	100
2.	Ibadan	95	102	-
3.	Ilorin	99	100	91
4.	Kaduna	100	103	98
5.	Benin	101	102	108
6.	Enugu	101	108	103
7.	Maiduguri	101	102	105
8.	Sokoto	112	113	108
9.	Kano	101	103	106
10.	Jos	104	102	-
11.	Calabar	-	-	101

FIG. 6.36

```
STATISTICAL ANALYSIS CLASSROOMS 1972


HISTOGRAM
OFFSET  =  0.5
CELL WIDTH  =  3
DATA
CONSTANT SUBTRACTED 94
             6.0000
             1.0000
             5.0000
             6.0000
             7.0000
             7.0000
             7.0000
            18.0000
             7.0000
            10.0000

N =  10
MEAN          =     101.4000
STD. DEV.     =      4.3512
SKEWNESS      =      1.1251
KURTOSIS      =      4.0140
XMIN          =      1.0000
XMAX          =     18.0000
RANGE         =     17.0000

C.VAR =     4.2912

CELL#              LOWER LIMIT      NO. OF OBS      %RELATIVE FREQ
1                  -1.0000          1               10.00000
2                   2.0000          0                0.00000
3                   5.0000          7               70.00000
4                   8.0000          1               10.00000
5                  11.0000          0                0.00000
6                  14.0000          0                0.00000
7                  17.0000          1               10.00000

EACH X =  1.75 PERCENT

-1.0000 .  *
        .XXXX*
 2.0000 .      *
        .         *
 5.0000 .             *
        .XXXXXXXXXXXXXXX*XXXXXXXXXXXXXXXXXXXXXXX
 8.0000 .                  *
        .XXXXX          *
11.0000 .            *
        .      *
14.0000 .    *
        .  *
17.0000 . *
        .X*XXX
20.0000 .*
```

FIG. 6.37

STATISTICAL ANALYSIS CLASSROOMS 1974

HISTOGRAM
OFFSET = 0.5
CELL WIDTH = 3
DATA
CONSTANT SUBTRACTED 90

10.0000
1.0000
8.0000
18.0000
13.0000
15.0000
18.0000
16.0000
11.0000

N = 9
MEAN = 102.2222
STD. DEV. = 5.4722
SKEWNESS = -0.7051
KURTOSIS = 2.3169
XMIN = 1.0000
XMAX = 18.0000
RANGE = 17.0000

C.VAR = 5.3532

CELL #	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-1.0000	1	11.11111
2	2.0000	0	0.00000
3	5.0000	0	0.00000
4	8.0000	2	22.22222
5	11.0000	2	22.22222
6	14.0000	2	22.22222
7	17.0000	2	22.22222

EACH X = 0.56 PERCENT

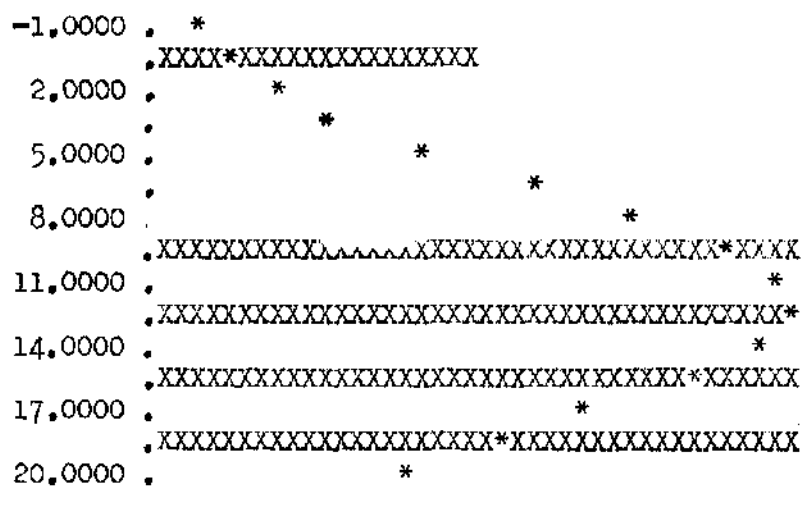


FIG. 6.39

CHAPTER 7

CHARACTERISTICS OF COST DATA

7.01 Reliability of Cost Indices

The accuracy of cost indices depends on the accuracy of the data on which they are based. Stone [17] points out that extensive studies have indicated that it is more or less impossible for an observer to choose a truly representative sample.

Many variables affect the cost of a building. The most important of these are listed in the introduction to this thesis. Any or all of them may vary from one contract to another. In addition to these variables, to arrive at the cost of a building it is necessary to synthesise the cost of the several hundred work items needed to complete the building. Each of these work items in addition to the known basic costs of labour and material contain estimates of the amount of labour required for the item, estimates of the amount of waste on materials and labour and in a number of cases estimates of the plant required. Fortunately these tend to be compensating or unbiased variables. This is proved later on in the chapter when it is shown that when materials with very high coefficients of variation are combined in a bill of quantities they still produce all in costs with values of V as low as 4 or 5.
The cost of a building will also vary according to the type of contract, ie. accurate Bills of Quantities, Approximate Quantities, Serial Contracts, Negotiation etc.

Seeley[2] says that for some years there has been a growing concern with regard to the degree of reliability of available building price indices in Britain. This concern stems partly from the lack of consistency between various published indices and partly by their failure to indicate the movement in building prices that experienced professionals in the building industry felt, from their own experience to have occurred. An additional and significant reason was the wide coverage of the majority of indices without regard to specific locality or building type.

Sweett[18] emphasises the point that cost data should never be transferred indiscriminately from a bill of quantities to an estimate. Allowances must be made for differences in tender dates, contract conditions, regional differences, type of contractor, site conditions, availability

local labour and materials, any abnormalities in pricing and prevailing economic conditions.

Southwell[19] has also referred to the need to make adjustments for differences in tendering keenness and price levels generally. The only possible indication of the general keenness in tendering is the closeness of the tender figures. In some cases a very low tender is so exceptionally low that it throws doubt upon its use as a basis for cost analysis. Seeley[2] says that for these reasons, probably the most reliable information is that based on approximate quantities prepared for each design and priced by an experienced quantity surveyor, who will make allowance for relevant abnormal and local conditions.

It has been argued that an analysis of the second lowest tender would provide a more accurate indication of real costs on the ground that this would eliminate an exceptionally low tender. It is considered however that any advantage gained on a small proportion of contracts would be outweighed by the slightly high tenders used for the majority of the contracts. It has also been suggested that the final cost of a building should be used as a basis for analysis. This could be misleading as the final cost is not known until all the work has been completed and it may include for variations and increased costs of materials after the date of tender. It is more reasonable to assume that the amount of the accepted tender represents the actual cost of the building at the date the tender is submitted. The historical cost data used in this research is based on the pricing of approximate quantities by experienced quantity surveyors.

Southwell[19] has also described how the builder's price is the building owners cost, and when we are using data provided by bills of quantities for cost analysis, it is cost-to-client in respect of elements of design rather than the cost-to-contractor, with which we are concerned. He has emphasised that the distinction between cost and price is not merely an academic terminological issue. The fact that there is lack of coincidence between the unit of production cost and unit of design cost accounts for some part of the wide discrepancy between unit rates in bills of quantities.

7.02 Statistical Analysis

The suitability of groups of cost data for use in the preparation of cost indices can be checked by statistical analysis.

The statistical work comprises the investigation of the dispersion around the mean of groups of building costs. The costs of the buildings are expressed as costs per square metre of floor area. The costs of say a number of classroom blocks would be gathered together as a representative sample of a particular population of classroom block costs and various statistical measures of the samples calculated. These statistical measures would give the dispersion about the mean and an indication of the shape of the population distribution. It was hoped that of the groups of costs investigated some would have dispersions small enough so that the mean costs could be used as a basis for estimating. The homogeneity, or resemblance, of the various groups of cost is measured by calculating the coefficient of variation - V - of each. This is the standard deviation expressed as a percentage of the mean.

$$V = \frac{\text{standard deviation}}{\text{Mean}} \times 100 = \frac{\sigma}{m} \times 100$$

It is used as a measure of the relative dispersion of a distribution. It is assumed that any groups of cost having a 'V' greater than 10% would not be useful for estimating purposes. A value of 'V' of 10% would mean, assuming the population to be normally distributed, that for 95% certainty in any prediction the mean cost plus or minus 20% would have to be used. This calculation is shown in Fig. 7.00A

The statistical measures were calculated using Hewlett Packard model HP 9830A programmable calculator. A general listing of the programme used is shown in Fig. 7.01.

7.03/

7.03 The main features of the data are:-

(a) The large variations in cost due to location.

(b) the very high coefficients of variation for the historical cost data.

(c) the low coefficients of variation for the unit rate data, and

(d) the reasonable variables in the time scales.

LISTING OF STATISTICAL PROGRAMME FOR BUILDING LOCATION COST INDICES

NIGERIA

```
10    DISP "CONSTANT SUBTRACTED";
20    INPUT K
21    PRINT "CONSTANT SUBTRACTED" K
30    DISP "X("N+1")=";
40    INPUT X
50    X=X-K
60    Z =FNX(1)
70    GOTO 30
80    END

10    M=S1/N
20    S=SQR((S2-M*M*N)/(N-1))
30    M3=S3/N-3*M*S2/N+2*M^3
40    M4=S4/N-4*M*S3/N+6*(M^2)*S2/N
50    M4=M4-3*M 4
60    FORMAT F12.4,/,F12.4/,F12,4,/,F12.4
70    PRINT
80    PRINT "N="N
90    WRITE (15,60)"MEAN="M+K,"STD.DEV="S,"SKEWNESS="M3/S 3,"KURTOSIS="M4/" 4
100   IF T1=0 THEN 120
110   ORINT "MIN,MAX,RANGE MAY BE INCORRECT"
120   WRITE (15,60)"XMIN="R1, "XMAX="R2, "RANGE="R2-R1
130   WRITE (15,140)"C.VAR.="(S/(M+K))*100
140   FORMAT F12.4
150   IF R3=0 THEN 170
160   PRINT "NO. TOO SMALL="R3
170   IF R4=0 THEN 190
180   PRINT "NO. TOO LARGE="R4
190   END

10    PRINT
 1    FORMAT F5.0,F12.4,F11.0,F17.5
12    PRINT "CELL#;""    LOWER LIMIT";
13    PRINT TAB18;"  NO. OF OBS";" %RELATIVE FREQ"
30    Y=FNC(1)
40    OR I=1 to B
45 WRITE (15,11)I,0+(I-1.5)*C,A(I),100*A(I)/N
50    NEXT I
60    FOR J=1 TO 10
70    PRINT
80    NEXT J
90    END
```

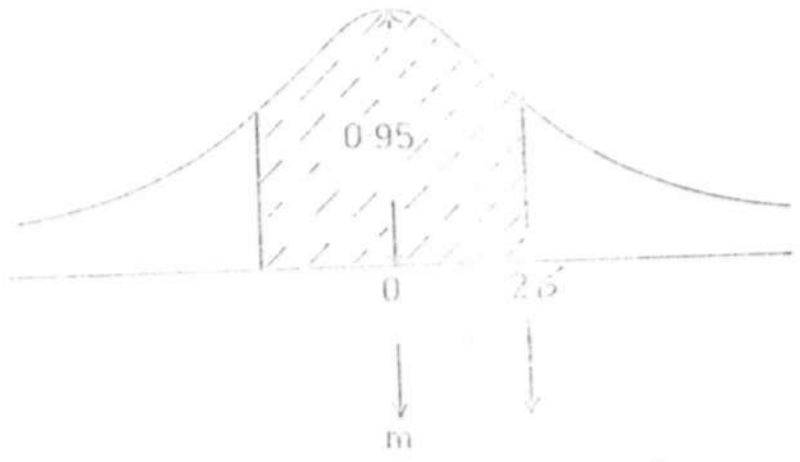
FIG. 7.01

COEFFICIENT OF VARIATION

$$V = 10\% \implies \frac{\sigma}{m} \times 100 = 10$$

$$\therefore \quad \sigma = \frac{m}{10}$$

FOR 95% CERTAINTY



$$m + \frac{2m}{10}$$

$$= \frac{6m}{5}$$

$$= m + 20\%$$

FIG. 7.01A

SUMMARY: LOCATION INDEXES

BUILDINGS	YEAR	L.	W.	KW.	N.C	M.W	E.C	N.E.	N.W.	K.	B.P.
Classrooms	1968	100	-	123	143	94	-	150	-	133	94
Administration	1968	100	-	96	148	-	-	118	132	-	76
Dormitories	1968*	-	-	126	128	100	-	125	-	-	-
Assembly Hall	1968	100	-	111	97	-	-	93	124	100	104
Houses	1968	100	98	119	-	109	-	140	-	-	113
Sec. Schools	1968	100	99	78	70	64	-	104	-	71	100
Craft Schools	1968*	-	-	162	122	100	-	134	141	-	136*
All Schools	1968	100	62	100	92	67	-	111	107	71	106
Mean	1968	100	86	105	110	84	-	119	121	94	99
Classrooms	1969	100	125	132	140	107	-	152	-	134	107
Administration	1969	100	-	142	148	98	-	141	135	-	95
Dormitories	1969*	-	102	111	110	100	-	-	-	86	107
Assembly Hall	1969	100	-	106	109	-	-	98	102	108	101
Houses	1969	100	88	-	132	-	-	120	-	117	120
All schools	1969	100	61	91	79	63	-	105	107	-	87
Mean	1969	100	91	118	122	89	-	123	115	120	102
Classrooms	1972	100	95	99	100	101	101	101	112	101	104
Classrooms	1973	100	102	100	103	102	108	102	113	103	102
Classrooms	1974	100	-	91	98	108	103	105	108	106	-
Mean											
'69,'72,'73,'74		100	94	103	107	97	104	110	114	105	102

FIG. 7.02

* EXCLUDED FROM MEAN

ITEM	YEAR	NO. IN SAMPLE	MEAN	STD.DEV.	SKEW	KURT.	RANGE	C.VAR.
1. Location Index All Buildings	1967	26	101.12	15.153	0.172	3.426	71.00	14.986
2. Location Index Classrooms	1968	16	113.94	24.786	0.407	1.621	81.00	21.754
3. Location Index Administration Blocks	1968	14	106.14	25.035	-0.034	1.739	86.00	23.586
4. Location Index Assembly Halls	1968	15	101.00	21.210	0.605	2.268	71.00	21.000
5. Location Index Housing	1968	15	121.40	18.469	0.238	1.453	51.00	15.214
6. Location Index Secondary Schools	1968	42	82.79	24.641	0.313	1.694	84.00	29.765
7. Location Index All Schools	1968	59	81.02	32.320	0.753	4.097	159.00	39.893
8. Location Index Classrooms	1969	17	121.35	18.364	0.135	1.415	58.00	15.133
9. Location Index Administration Blocks	1969	13	122.00	26.458	-0.311	1.440	81.00	21.686
10. Location Index Assembly Halls	1969	13	103.08	9.429	-0.792	2.477	31.00	9.148
11. Location Index Housing	1969	12	115.83	16.921	-0.227	1.399	47.00	14.608
12. Location Index All Schools	1969	46	71.65	18.594	0.879	2.568	74.00	25.951
13. Location Index All Buildings	1970	15	118.33	28.547	0.980	3.277	106.00	24.125
14. Location Index Classrooms	1972	10	101.40	4.351	1.125	4.041	17.00	4.291
15. Location Index Classrooms	1973	10	103.50	4.007	1.320	3.443	13.00	3.871
16. Location Index Classrooms	1974	9	102.22	5.472	-0.705	2.317	17.00	5.353

FIG. 7.03

7.04 LOCATION COSTS

In some countries location is not considered to be an important influence on building costs. Seeley[2], Wrobel[14] and Kouskoulas[20] have all mentioned this although Seeley does express doubts about the truth of the statement. In Nigeria location has proved to be a major factor. With the historical cost data ranges of up to 50% have been found between various locations. Admittedly, part of the difference is due to changes in specification, structural form and site conditions but a large portion seems to be due to location. With the unit rate data where the same building was used for all ten locations the costs varied up to a maximum of 13% which could all be attributed direct to location. It is clear that any system adopted for the preparation of building cost indices in Nigeria must take full account of the location variable. A list of the factors affecting location costs are given in the conclusion to the thesis.

7.05 Coefficients of Variation for Historical Costs Data

The coefficients of variation for the various groupings of historical cost data are very high ranging from 15% to 40%. All are well outside the arbitrary limit of 10%. This indicates that the data is not suitable, from the statistics point of view, for use in the preparation of pre-design estimates. Wrobel[14] who carried out a similar study using B.C.I.S. cost data, in Britain, for groups of the same type of buildings obtained similar results with coefficients of variation ranging from 10% to 36%. Only one type, secondary schools, approached the arbitrary limit of 10%. Other examples were banks 17% offices 32% and factories 36%.
In an effort to isolate the factors contributing to these large dispersions a group of classrooms from the 1969 data were analysed into costs per element i.e. substructure, frame, roof, external walls, internal walls, fixtures and fittings, services and sub-total less roof. The latter was usedas the roof construction was the major design variable between the classroom blocks. It was hoped that this method by comparing groups of the same element ie. like with like would produce better results. This did not happen. With one exception the groups of element costs produced higher coefficients of variation than that obtained using a group of total costs. This suggests that the variables in the total costs are unbiased.

As/

As a further check the group of classroom costs were sub-divided into total cost less one element, total less two elements etc. In each case statistical analysis produced higher coefficients of variation than those obtained using total costs. Details of this analysis are shown in Figs. 7.04 to 7.12 and in Figs. 7.55 to 7.89.

CLASSROOMS 1969

HISTOGRAM

OFFSET = 0.5
CELL WIDTH = 6
DATA
CONSTANT SUBTRACTED 99

35.0000
1.0000
4.0000
12.0000
21.0000
39.0000
38.0000
10.0000
8.0000
1.0000

B = 10
MEAN = 115.9000
STD. DEV. = 15.2785
SKEWNESS = 0.4164
KURTOSIS = 1.3011
XMIN = 1.0000
XMAX = 39.0000
RANGE= 38.0000

C.VAR = 13.1825

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-2.5000	2	20.00000
2	3.5000	2	20.00000
3	9.5000	2	20.00000
4	15.5000	1	10.00000
5	21.5000	0	0.00000
6	27.5000	0	0.00000
7	33.5000	3	30.00000

EACH X = 0.75 PERCENT

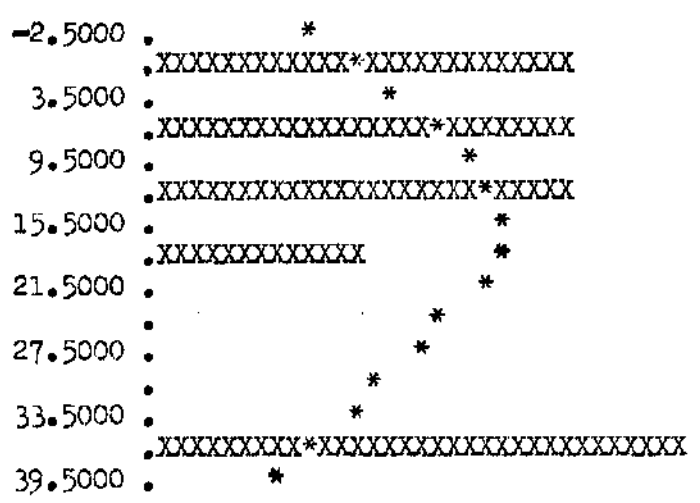


FIG. 7.04

STATISTICAL ANALYSIS SUBSTRUCTURE CLASSROOMS 1969

HISTOGRAM
OFFSET = 0.5
CELL WIDTH = 13
DATA
CONSTANT SUBTRACTED 4

48.0000
56.0000
44.0000
1.0000
78.0000
56.0000
23.0000
46.0000
39.0000
56.0000

N	=	10
MEAN	=	88.7000
STD. DEV.	=	20.8649
SKEWNESS	=	-0.5787
KURTOSIS	=	2.7165
XMIN	=	1.0000
XMAX	=	78.0000
RANGE	=	77.0000

C.VAR = 23.5230

CELL#	LOWER LIMIT	NO.OF OBS	%RELATIVE FREQ
1	-6.0000	1	10.00000
2	7.0000	0	0.00000
3	20.0000	1	10.00000
4	33.0000	2	20.00000
5	46.0000	5	50.00000
6	59.0000	0	0.00000
7	72.0000	1	10.00000

EACH X = 1.25 PERCENT

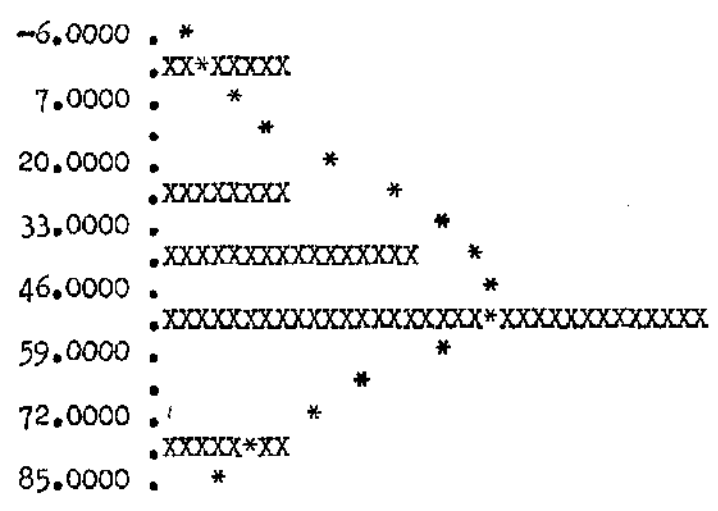


FIG. 7.05

STATISTICAL ANALYSIS CLASSROOMS ROOF 1969

HISTOGRAM

OFFSET = 0.5

CELL WIDTH = 27

DATA
CONSTANT SUBTRACTED 39

165.0000
61.0000
40.0000
1.0000
97.0000
100.0000
147.0000
30.0000
84.0000
61.0000

N = 10
MEAN = 117.6000
STD. DEV.= 51.0581
SKEWNESS = 0.2484
KURTOSIS = 1.7980
XMIN = 1.0000
XMAX = 165.0000
RANGE = 164.0000

C.VAR #	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-13.0000	1	10.00000
2	14.0000	2	20.00000
3	41.0000	2	20.00000
4	68.0000	1	10.00000
5	95.0000	2	20.00000
6	122.0000	1	10.00000
7	149.0000	1	10.00000

EACH X = 0.50 PERCENT

```
-13.0000 .       *
         .XXXXXXXXXXXXXX*XXXXXX
 14.0000 .                *
         .XXXXXXXXXXXXXXXXXXXXXXXXXX*XXXXXX
 41.0000 .                          *
         .XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 68.0000 .
         .XXXXXXXXXXXXXXXXXXX
 95.0000 .
         .XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
122.0000 .                                *
         .XXXXXXXXXXXXXXXXXXX    *
149.0000 .               *
         .XXXXXXXXXXX*XXXXXXXX
176.0000 .       *
```

FIG. 7.06

STATISTICAL ANALYSIS CLASSROOMS EXTERNAL WALLS 1969

HISTOGRAM
OFFSET = 0.5
CELL WIDTH = 50
DATA
CONSTANT SUBTRACTED 99

24.0000
1.0000
30.0000
79.0000
42.0000
297.0000
176.0000
232.0000
28.0000
1.0000

N = 10
MEAN = 190.0000
STD. DEV. = 105.6546
SKEWNESS = 0.8313
KURTOSIS = 1.9541
XMIN = 1.0000
XMAX = 297.0000
RANGE = 296.0000

C.VAR. = 55.6077

CELL #	LOWER LIMIT	NO. OF OBS	% RELATIVE FREQ
1	-24.5000	3	30.00000
2	25.5000	3	30.00000
3	75.5000	1	10.00000
4	125.5000	0	0.00000
5	175.5000	1	10.00000
6	225.5000	1	10.00000
7	275.5000	1	10.00000

EACH X = 0.75 PERCENT

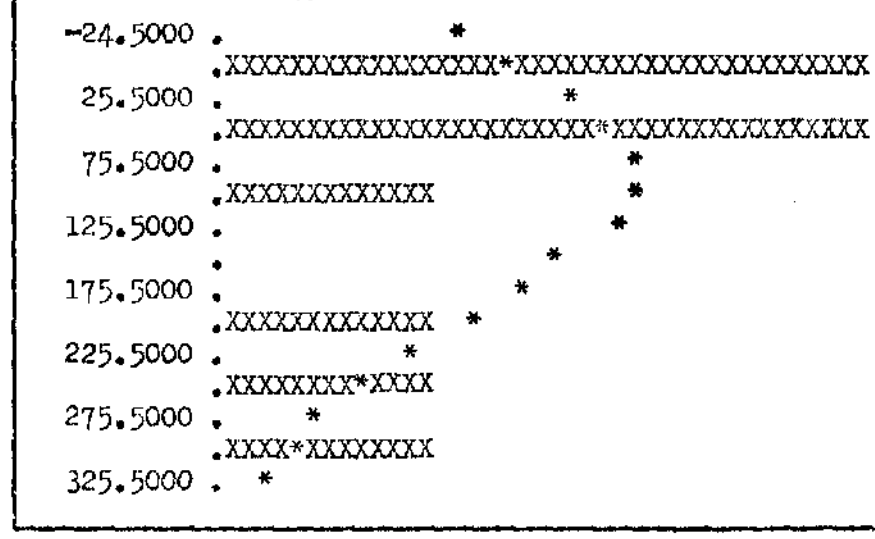


FIG. 7.07

STATISTICAL ANALYSIS CLASSROOMS INTERNAL WALLS 1969

HISTOGRAM
OFFSET = 0.5
CELL WIDTH = 20
DATA
CONSTANT SUBTRACTED 38

67.0000
62.0000
80.0000
125.0000
94.0000
1.0000
25.0000
18.0000
10.0000
62.0000

N = 10

MEAN	=	92.4000
STD. DEV	=	40.1309
SKEWNESS	=	0.1860
KURTOSIS	=	1.6303
XMIN	=	1.0000
XMAX	=	125.0000
RANGE	=	124.0000
C.VAR	=	43.4317

CELL #	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-9.5000	2	20.00000
2	10.5000	2	20.00000
3	30.5000	0	0.00000
4	50.5000	3	30.00000
5	70.5000	1	10.00000
6	90.5000	1	10.00000
7	110.5000	1	10.00000

EACH X = 0.75 PERCENT

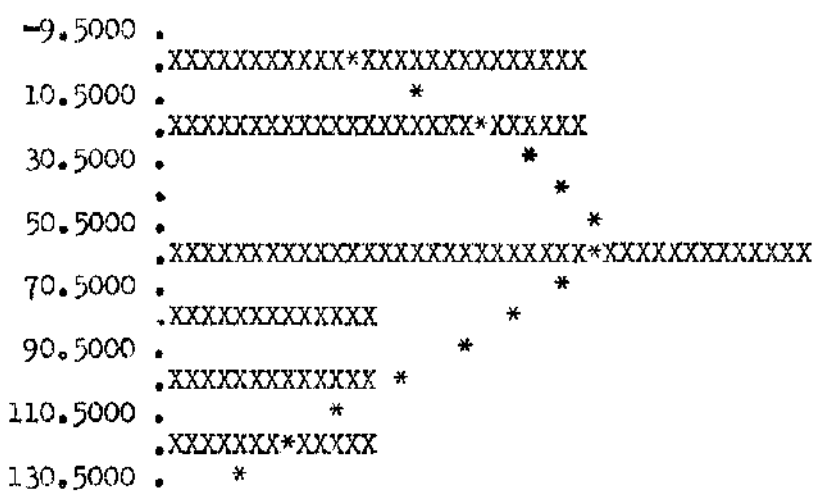


FIG. 7.08

CLASSROOMS FIXTURES and FITTINGS. 1969

```
HISTOGRAM
OFFSET    =    0.5
CELL WIDTH  =  23
DATA
CONSTANT SUBTRACTED  19
                21.0000
                81.0000
               139.0000
               123.0000
                 1.0000
                28.0000
                59.0000
                45.0000
                 5.0000
                81.0000

N      = 10
MEAN              =        77.3000
STD. DEV.         =        47.5396
SKEWNESS          =         0.3706
KURTOSIS          =         1.6079
XMIN              =         1.0000
XMAX              =       139.0000
RANGE             =         138.0000

C.VAR.            =        61.5001

CELL #          LOWER LIMIT       NO. OF OBS      %RELATIVE FREQ
1               -11.0000            2             20.00000
2                12.0000            2             20.00000
3                35.0000            1             10.00000
4                58.0000            1             10.00000
5                81.0000            2             20.00000
6               104.0000            1             10.00000
7               127.0000            1             10.00000
EACH X =  0.50 PERCENT

-11.0000 .          *
         .XXXXXXXXXXXXXXXXXX*XXXXXXXXXXXXXXXXXXXX
 12.0000 .                   *
         .XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX*XXXXXXXXX
 35.0000 .                            *
         .XXXXXXXXXXXXXXXXXXXX                 *
 58.0000 .                                       *
         .XXXXXXXXXXXXXXXXXXX                  *
 81.0000 .                                *
         .XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX*XXXXXXXXX
104.0000 .                   *
         .XXXXXXXXXXXXXXXXXXX*
127.0000 .             *
         .XXXXXXXXX*XXXXXXXXX
150.0000 .      *
```

FIG. 7.09

CLASSROOMS SERVICES 1969

HISTOGRAM
OFFSET = 0.5
CELL WIDTH = 50
DATA
CONSTANT SUBTRACTED 63

152.0000
37.0000
1.0000
104.0000
94.0000
78.0000
139.0000
36.0000
300.0000
37.0000

N = 10

MEAN	=	160.8000
STD. DEV.	=	85.9894
SKEWNESS	=	1.0846
KURTOSIS	=	3.3159
XMIN	=	1.0000
XMAX	=	300.0000
RANGE	=	299.0000
C.VAR	=	53.4760

CELL#	LOWER LIMIT	NO. OF OBS	% RELATIVE FREQ
1	-24.5000	1	10.00000
2	25.5000	3	30.00000
3	75.5000	3	30.00000
4	125.5000	2	20.00000
5	175.5000	0	0.00000
6	225.5000	0	0.00000
7	275.5000	1	10.00000

EACH X = 0.75 PERCENT

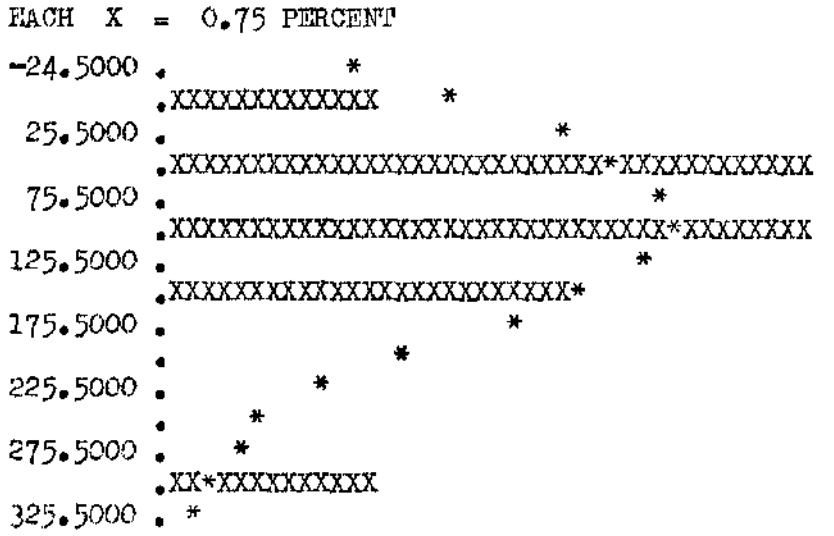


FIG. 7.1D

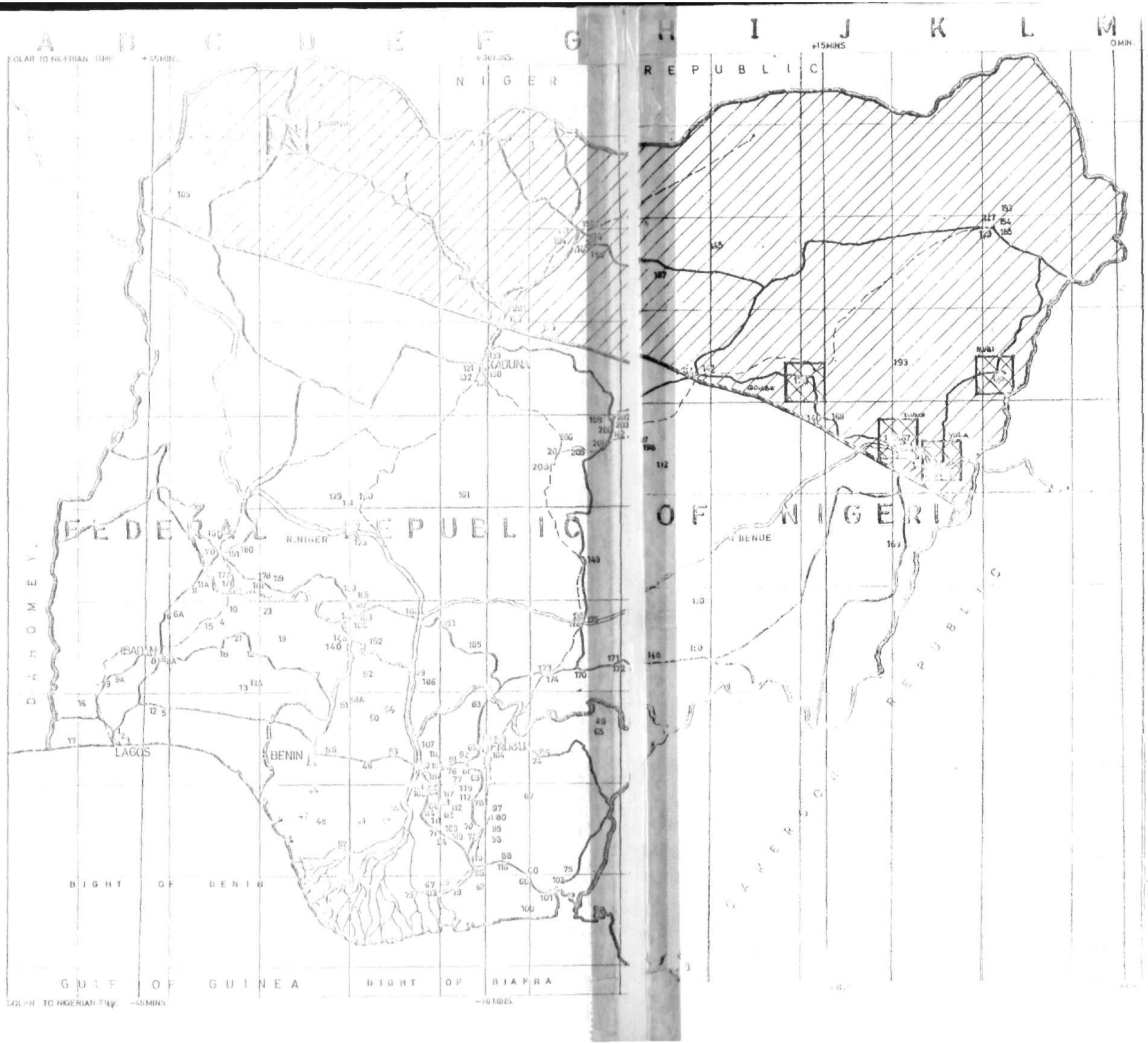
Location Costs/Index: Classrooms 1969

Summary Statistical Analysis of Elements

	Location		Total	Substructure	Frame	Roof	Ext. Walls	Int. Walls	Fixt.& Fittings	Services	Total less Roof	Specification Roof/Ceiling
1.	Kano	Cost	59.74	10.44	1.62	26.59	7.43	7.21	2.05	4.40	33.15	4" RC/Polly/C&S
		Index	134	92	-	204	123	105	40	215	105	
2.	Sabongida-Ora		44.46	11.30	-	13.02	6.03	6.89	5.17	2.05	31.44	Asb/T./Asb.&
			100	100	-	100	100	100	100	100	100	Poly.
3.	Sapele		45.67	9.96	-	10.31	7.78	8.15	8.15	1.32	35.36	Al./T./Poly.
			103	88	-	79	129	118	158	64	112	
4.	Benin		49.51	5.06	6.57	5.17	10.76	11.20	7.32	3.43	44.34	Al./M.S./Insul.
			111	45	-	40	178	163	142	167	141	Brd.
5.	Ilorin		53.37	13.80	-	17.77	8.49	9.09	1.01	3.21	35.60	Al./T./Celotex
			120	122	-	136	141	132	20	157	113	
6.	Okene		61.24	11.30	-	18.05	23.84	2.70	2.45	2.90	43.19	Al/T.Asb.
			138	100	-	139	396	39	47	141	137	
7.	Zaria		60.90	7.53	-	24.17	16.64	4.37	4.05	4.14	36.73	Asb./M.S./Asb.
			137	67	-	186	275	63	78	202	117	1" Celotex 2"C&S
8.	Makurdi		48.33	10.19	-	8.96	19.97	3.88	3.31	2.02	39.37	Asb./R.C ./Poly
			109	90	-	69	331	56	64	99	125	
9.	Ijebu-Ode		47.72	9.38	-	15.97	10.38	3.28	1.26	7.45	31.75	Al/T./1" Fibre.
			107	83	-	123	127	48	24	363	101	glass & Asb.
10.	Lagos		44.46	11.30	-	13.02	6.03	6.89	5.17	2.05	31.44	Al./T./Asb.
			100	100	-	100	100	100	100	100	100	& Poly.
	C.Var.(Index)		13.183	23.523	-	43.417	55.608	43.432	61.500	53.476	12.920	

FIG. 7.12

I. D. A.



KEY

APPROXIMATE LIMITS OF SURVEYED AREA

AREAS OF RECORDED FAILURES (NOT EXTENSIVELY MAPPED)

FIG. 7.13

I D A

EDUCATION PROJECT NIGERIA

MAP OF AREAS OF SPECIAL FOUNDATION PROBLEMS IN NORTHERN NIGERIA

BUILDING MATERIALS

COSTS 1972

MATERIAL	LAGOS	IBADAN	ILORIN	KADUNA	BENIN	MAIDUGURI	SOKOTO	KANO	JOS	ENUGU
1. Cement tonne	38.38	38.4	47.2	46.3	41.3	53.1	68.9	49.2	59.5	39.4
2. 19 mm Aggregate M^3	6.54	6.54	5.89	6.54	6.54	5.89	6.54	6.54	3.27	6.54
3. 12 mm Dia M.S.rod kg	0.23	0.22	0.38	0.25	0.25	0.24	0.32	0.20	0.24	0.19
4. Formwork timber M^3	70.6	60	63.6	63.6	53	60	63.6	66.4	63.6	53
5. Hardboard M^3	0.53	0.38	0.60	0.75	1.43	0.45	0.60	0.68	0.60	0.45
6. 450x225x225 Blocks No.	0.12	0.15	0.25	0.20	0.35	0.20	0.30	0.18	0.30	0.15
7. Asbestos roofing M^2	1.28	0.98	0.90	0.28	1.28	0.90	0.53	0.68	0.60	0.90
8. Aluminium roofing M^2	3.39	6.85	5.12	3.39	3.39	3.39	0.23	3.61	8.88	4.14
9. Wall tiles per 100	1.40	11.0	10.0	14.0	12.5	12.0	12.0	10.0	9.50	9.25
10. Glass M^2	2.54	1.96	2.03	2.26	2.26	2.26	3.76	2.26	2.03	1.58
11. Emulsion paint litres.	1.31	1.56	1.76	1.65	1.43	1.54	1.98	1.51	1.43	1.53

FIG. 7.14

BUILDING MATERIALS

COSTS 1973

	LAGOS	IBADAN	ILORIN	KADUNA	BENIN	N/GURI	SOKOTO	KANO	JOS	ENUGU
1. Cement tonne	38.4	38.4	47.2	55.1	41.3	62.3	68.9	59.1	39.6	39.4
2. 19 mm Aggregate M^3	7.85	7.85	4.71	7.85	7.85	7.85	7.85	7.85	7.85	7.85
3. 12 mm Dia. M.S. rod kg.	0.20	0.39	0.35	0.22	0.27	0.26	0.44	0.20	0.26	0.30
4. Formwork Timber M^3	84.8	72	53	76.3	63.6	72	76.3	79.8	63.6	63.6
5. Hardboard M^2	0.53	0.68	0.60	0.90	0.75	0.60	0.68	0.45	0.53	0.60
6. 450x225x225 Block No.	0.20	0.20	0.22	0.25	0.35	0.20	0.30	0.23	0.22	0.25
7. Asbestos roofing M^2	1.20	0.98	2.03	1.43	1.20	1.05	0.60	1.20	1.13	1.13
8. Aluminium roofing M^2	5.12	5.12	3.39	5.04	5.12	5.12	6.17	5.27	5.42	6.17
9. Wall tiles per 100	9.50	10.0	7.10	9.75	9.50	15.0	13.0	11.1	12.0	10.0
10. Glass M^2	2.56	1.73	1.88	2.03	2.26	2.48	3.76	2.18	2.03	1.73
11. Emulsion paint litres	1.56	1.76	1.39	1.77	1.79	1.83	2.10	1.77	1.78	1.76

FIG 7.15

COSTS 1974

	LAGOS	IBADAN	ILORIN	KADUNA	BENIN	N/GURI	SOKOTO	KANO	ENUGU	CALABAR
1. Cement tonne	43.3	-	68.9	92.5	59.1	84.6	88.6	90.5	76.8	74.8
2. 19 mm Aggregate M^3	9.16	-	9.16	9.16	9.16	9.16	9.16	9.16	9.16	9.16
3. 12 mm Dia. M.S. rod kg.	0.34	-	0.35	0.47	0.49	0.44	0.39	0.45	0.36	0.71
4. Formwork timber M^3	53	-	124	53	159	70.6	88.3	81.9	88.3	61.1
5. Hardboard M^3	0.45	-	0.60	0.23	0.75	0.30	0.83	0.90	0.60	0.53
6. 450x225x225 Block No.	0.41	-	0.30	0.35	0.45	0.25	0.30	0.30	0.49	0.28
7. Asbestos Roofing M^2	1.05	-	0.60	1.28	1.13	1.28	1.58	1.28	1.13	0.98
8. Aluminium roofing M^2	4.82	-	6.02	3.61	4.97	5.79	6.17	5.49	4.14	4.44
9. Wall tiles per 100	12	-	15	17	14	16	17	15	16	14
10. Glass M^2	2.26	-	2.26	6.02	3.76	4.74	2.26	3.01	4.52	2.26
11. Emulsion paint litres	1.91	-	2.31	1.68	2.20	2.11	2.31	2.24	1.75	1.23

FIG. 7.16

BUILDING MATERIALS

LOCATION INDEX 1972

MATERIAL	LAGOS	IBADAN	ILORIN	KADUNA	BENIN	M/GURI	SOKOTO	KANO	JOS	ENUGU
1. Cement	100	100	123	121	108	138	179	128	154	103
2. 19 mm Aggregate	100	100	90	100	100	90	100	100	50	100
3. 12 mm Dia. M.S. rod	100	92	163	104	104	103	137	87	103	81
4. Formwork Timber	100	85	90	90	75	85	90	94	90	75
5. Hardboard	100	71	144	143	271	86	114	129	114	86
6. 450x225x225 mm Blocks	100	125	208	167	292	167	250	150	250	125
7. Asbestos roofing	100	76	71	100	100	71	41	53	47	71
8. Aluminium roofing	100	202	151	100	100	100	302	107	262	122
9. Glass	100	76	79	88	88	88	147	88	79	62
10. Emulsion paint	100	119	134	126	109	118	151	116	109	117
11. Wall litres	100	79	71	100	89	86	86	71	68	66

FIG. 7.17

LOCATION INDEX 1973

MATERIAL	LAGOS	IBADAN	ILORIN	KADUNA	BENIN	M/GURI	SOKOTO	KANO	JOS	ENUGU
1. Cement	100	100	123	144	108	164	179	154	103	103
2. 19 mm Aggregate	100	100	60	100	100	100	100	100	100	100
3. 12 mm Dia. M.S. rod	100	200	180	113	135	133	225	104	132	150
4. Formwork timber	100	85	63	90	75	85	90	94	75	75
5. Hardboard	100	129	114	171	143	114	129	86	100	114
6. 450x225x225 mm Blocks	100	100	110	125	175	100	150	115	110	125
7. Asbestos roofing	100	81	169	119	100	88	50	100	94	94
8. Aluminium roofing	100	100	66	99	100	100	121	103	106	121
9. Wall tiles	100	105	75	103	100	158	136	116	126	105
10. Glass	100	68	74	79	88	97	147	85	79	68
11. Emulsion paint	100	113	89	113	115	117	134	113	114	113

FIG. 7.18

BUILDING MATERIALS
LOCATION INDEX 1974

MATERIALS	LAGOS	IBADAN	ILORIN	KADUNA	BENIN	MAIDUGURI	SOKOTO	KANO	ENUGU	CALABAR
1. Cement	100	"	159	214	136	195	205	209	177	173
2. 19 mm Aggregate	100	"	100	100	100	100	100	100	100	100
3. 12 mm "Dia. M.S. rod	100	"	105	140	146	131	117	133	108	211
4. Formwork timber	100	"	233	100	300	133	167	155	167	115
5. Hardboard	100	"	133	50	167	67	183	200	133	117
6. 450x225x225 MM Blocks	100	"	73	85	110	61	73	73	120	68
7. Asbestos roofing	100	"	57	121	107	121	150	121	107	93
8. Aluminium roofing	100	"	125	75	103	120	128	114	86	92
9. Wall tiles	100	"	125	142	117	133	142	125	133	117
10. Glass	100	"	88	235	147	185	88	118	176	88
11. Emulsion paint	100	"	121	88	115	110	121	117	91	64

FIG. 7.19

STATISTICAL ANALYSIS CEMENT 1972

HISTOGRAM
OFFSET= 0.5
CELL WIDTH = 13
DATA
CONSTANT SUBTRACTED 99

1.0000
1.0000
24.0000
22.0000
9.0000
39.0000
80.0000
29.0000
55.0000
4.0000

N= 10
MEAN= 125.4000
STD.DEV= 25.7691
SKEWNESS= 0.7598
KURTOSIS= 2.2960
XMIN= 1.0000
XMAX= 80.0000
RANGE= 79.0000

C.VAR.= 20.5495

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-6.0000	3	30.00000
2	7.0000	1	10.00000
3	20.0000	3	30.00000
4	33.0000	1	10.00000
5	46.0000	1	10.00000
6	59.0000	0	0.00000
7	72.0000	1	10.00000

EACH X = 0.75 PERCENT

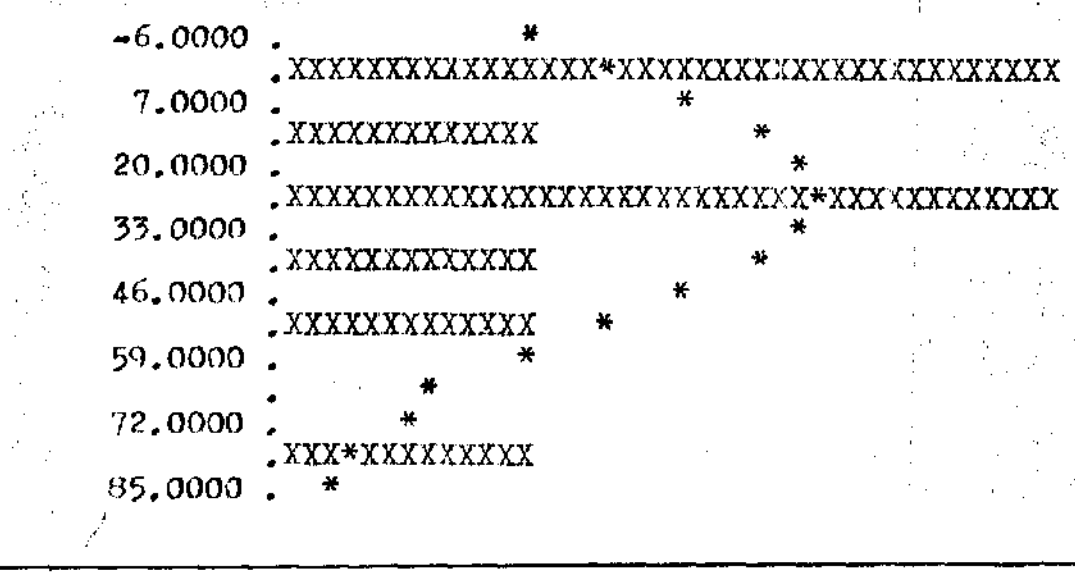


FIG. 7.20

STATISTICAL ANALYSIS AGGREGATE 1972

HISTOGRAM
OFFSET= 0.5
CELL WIDTH = 8
DATA
CONSTANT SUBTRACTED 49

51.0000
51.0000
41.0000
51.0000
51.0000
41.0000
51.0000
51.0000
1.0000
51.0000

N= 10
MEAN= 43.0000
STD.DEV= 15.6702
SKEWNESS= -2.0052
KURTOSIS= 5.6930
XMIN= 1.0000
XMAX= 51.0000
RANGE= 50.0000

C.VAR.= 16.8497

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-3.5000	1	10.00000
2	4.5000	0	0.00000
3	12.5000	0	0.00000
4	20.5000	0	0.00000
5	28.5000	0	0.00000
6	36.5000	2	20.00000
7	44.5000	7	70.00000

EACH X = 1.75 PERCENT

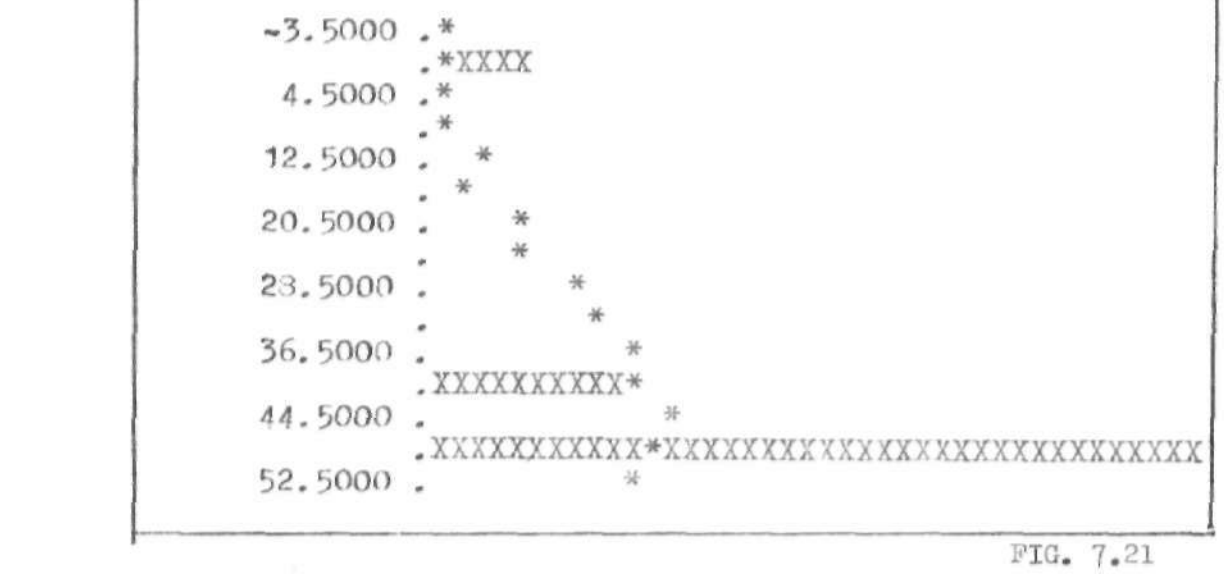


FIG. 7.21

```
          STATISTICAL ANALYSIS    ROD 1972
HISTOGRAM
OFFSET=  0.5
CELL WIDTH =  12
DATA
CONSTANT SUBTRACTED 80
     20.0000
     12.0000
     83.0000
     24.0000
     24.0000
     23.0000
     57.0000
      7.0000
     23.0000
      1.0000

N= 10
MEAN=     107.4000
STD.DEV=      24.5728
SKEWNESS=       1.1229
KURTOSIS=       3.0289
XMIN=        1.0000
XMAX=       83.0000
RANGE=       82.0000

C.VAR.=      22.8797
CELL#    LOWER LIMIT    NO. OF OBS  %RELATIVE FREQ
    1      -5.5000           1          10.00000
    2       6.5000           2          20.00000
    3      18.5000           5          50.00000
    4      30.5000           0           0.00000
    5      42.5000           0           0.00000
    6      54.5000           1          10.00000
    7      66.5000           0           0.00000
    8      78.5000           1          10.00000


EACH X = 1.25  PERCENT

     -5.5000 .       *
             .XXXXXXXX *
      6.5000 .          *
             .XXXXXXXXXXXXX*XX
     18.5000 .                *
             .XXXXXXXXXXXXXXX*XXXXXXXXXXXXXXXXXXXXXXXXX
     30.5000 .                 *
             .                  *
     42.5000 .                   *
             .                 *
     54.5000 .               *
             .XXXXXX*X
     66.5000 .     *
             .   *
     78.5000 .   *
             .X*XXXXXX
     90.5000 . *
```

FIG. 7.22

STATISTICAL ANALYSIS TIMBER 1972

HISTOGRAM
OFFSET= 0.5
CELL WIDTH = 4
DATA
CONSTANT SUBTRACTED 74

26.0000
11.0000
16.0000
16.0000
1.0000
11.0000
16.0000
20.0000
16.0000
1.0000

N= 10
MEAN= 37.4000
STD.DEV= 7.3060
SKEWNESS= -0.3117
KURTOSIS= 2.0102
XMIN= 1.0000
XMAX= 26.0000
RANGE= 25.0000

C.VAR.= 8.9313

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-1.5000	2	20.00000
2	2.5000	0	0.00000
3	6.5000	0	0.00000
4	10.5000	2	20.00000
5	14.5000	4	40.00000
6	18.5000	1	10.00000
7	22.5000	1	10.00000

EACH X = 1.00 PERCENT

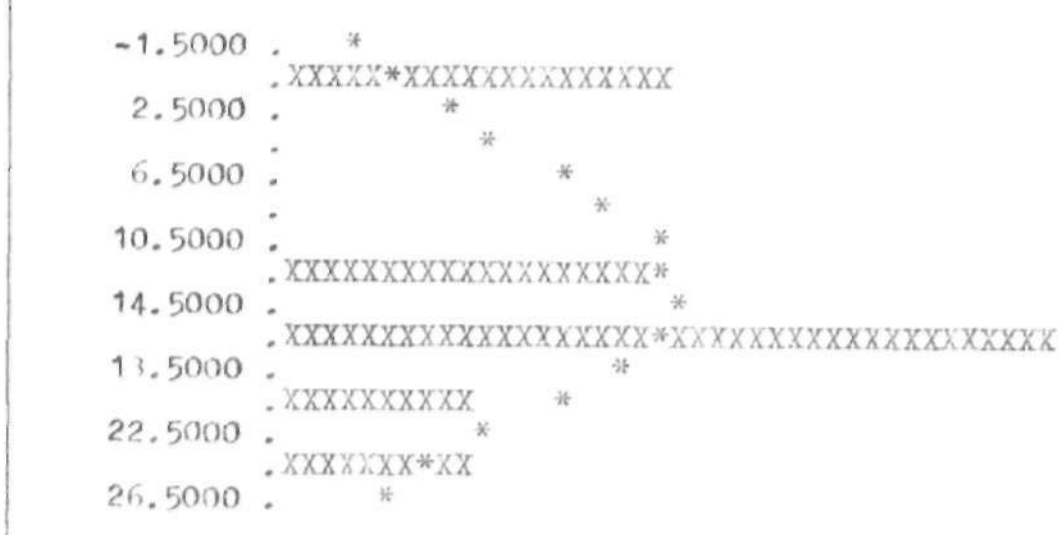


FIG. 7.23

STATISTICAL ANALYSIS HARDBOARD 1972

HISTOGRAM
OFFSET= 0.5
CELL WIDTH = 34
DATA
CONSTANT SUBTRACTED 70

30.0000
1.0000
44.0000
73.0000
201.0000
16.0000
44.0000
59.0000
44.0000
16.0000

N= 10
MEAN= 122.8000
STD.DEV= 56.3260
SKEWNESS= 1.6849
KURTOSIS= 4.9049
XMIN= 1.0000
XMAX= 201.0000
RANGE= 200.0000

C.VAR.= 45.8681

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-16.5000	3	30.00000
2	17.5000	4	40.00000
3	51.5000	2	20.00000
4	85.5000	0	0.00000
5	119.5000	0	0.00000
6	153.5000	0	0.00000
7	187.5000	1	10.00000

EACH X = 1.00 PERCENT

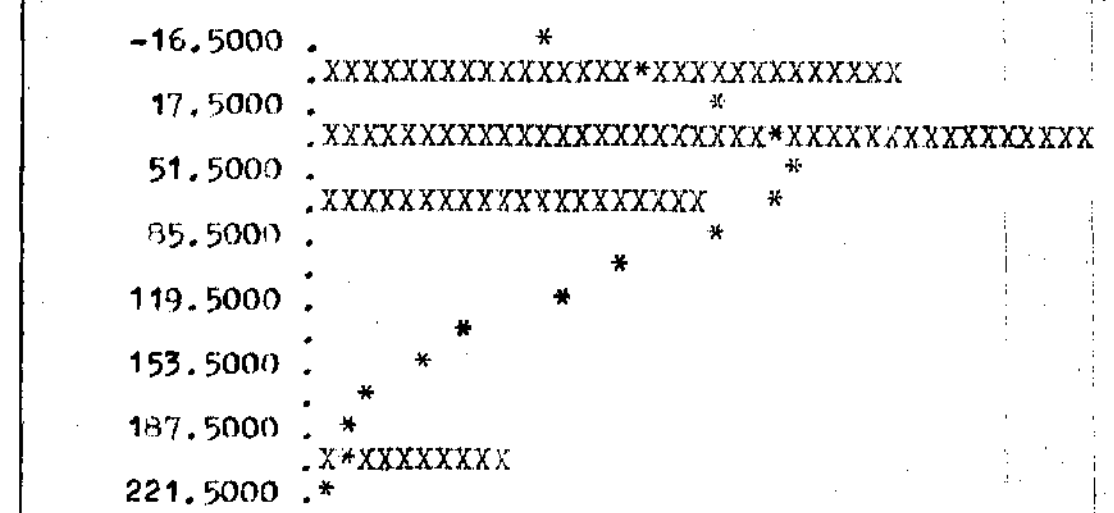


FIG. 7.24

```
          STATISTICAL ANALYSIS    BLOCKS 1972
HISTOGRAM
OFFSET=  0.5
CELL WIDTH =  32
DATA
CONSTANT SUBTRACTED 99
       1.0000
      26.0000
     109.0000
      68.0000
     193.0000
      68.0000
     151.0000
      51.0000
     151.0000
      26.0000

N= 10
MEAN=     133.4000
STD.DEV=      63.3573
SKEWNESS=       0.3310
KURTOSIS=       1.5145
XMIN=       1.0000
XMAX=     193.0000
RANGE=     192.0000

C.VAR.=      34.8139
CELL#    LOWER LIMIT    NO. OF OBS   %RELATIVE FREQ
    1     -15.5000          1          10.00000
    2      16.5000          2          20.00000
    3      48.5000          3          30.00000
    4      80.5000          1          10.00000
    5     112.5000          0           0.00000
    6     144.5000          2          20.00000
    7     176.5000          1          10.00000

EACH X = 0.75  PERCENT

 -15.5000 .        *
          .XXXXXXXXXX*X
  16.5000 .           *
          .XXXXXXXXXXXXXXXXXX*XXXXXX
  48.5000 .                 *
          .XXXXXXXXXXXXXXXXXXXXXXX*XXXXXXXXXXXX
  80.5000 .                    *
          .XXXXXXXXXXXXX        *
 112.5000 .                     *
          .                   *
 144.5000 .              *
          .XXXXXXXXXXXXX*XXXXXXXXXXX
 176.5000 .         *
          .XXXXXX*XXXXXX
 208.5000 .    *
```

FIG. 7.25

```
                STATISTICAL ANALYSIS  ASBESTOS 1972
HISTOGRAM
OFFSET=  0.5
CELL WIDTH =  10
DATA
CONSTANT SUBTRACTED 40
      60.0000
      36.0000
      31.0000
      60.0000
      60.0000
      31.0000
       1.0000
      13.0000
       7.0000
      31.0000

N= 10
MEAN=      73.0000
STD.DEV.=      21.3785
SKEWNESS=       0.0063
KURTOSIS=       1.4223
XMIN=      1.0000
XMAX=     60.0000
RANGE=     59.0000

C.VAR.=     29.2705
CELL#    LOWER LIMIT    NO. OF OBS   %RELATIVE FREQ
   1      -4.5000          1            10.00000
   2       5.5000          2            20.00000
   3      15.5000          0             0.00000
   4      25.5000          3            30.00000
   5      35.5000          1            10.00000
   6      45.5000          0             0.00000
   7      55.5000          3            30.00000

EACH X = 0.75  PERCENT

 -4.5000 .      *
         .XXXXXXXX*XXX
  5.5000 .         *
         .XXXXXXXXXXXXXX*XXXXXXXXXX
 15.5000 .                *
         .                 *
         .                    *
 25.5000 .                     *
         .XXXXXXXXXXXXXXXXXXXXXXX*XXXX XXXXXXXXXX
 35.5000 .                       *
         .XXXXXXXXXXXXXX          *
 45.5000 .                         *
         .                   *
         .                *
 55.5000 .              *
         .XXXXXXXXXX*XXXXXXXXXXXXXXXXXXXXXXXXXXXX
 65.5000 .          *
```

FIG. 7.26

```
                    STATISTICAL ANALYSIS ALGORITHM 1972
HISTOGRAM
OFFSET=  0.5
CELL WIDTH =  33
DATA
CONSTANT SUBTRACTED 99
       1.0000
     103.0000
      52.0000
       1.0000
       1.0000
       1.0000
     203.0000
       8.0000
     163.0000
      23.0000

N= 10
MEAN=      154.6000
STD.DEV=    75.1106
SKEWNESS=    0.3860
KURTOSIS=    2.0434
XMIN=        1.0000
XMAX=      203.0000
RANGE=     202.0000

C.VAR.=     48.5838
CELL#    LOWER LIMIT    NO. OF OBS   %RELATIVE FREQ
   1      -16.0000          5          50.00000
   2       17.0000          1          10.00000
   3       50.0000          1          10.00000
   4       83.0000          1          10.00000
   5      116.0000          0           0.00000
   6      149.0000          1          10.00000
   7      182.0000          1          10.00000

EACH X = 1.25  PERCENT

    -16.0000 .          *
             .XXXXXXXXXXX*XXXXXXXXXXXXXXXXXXXXXXXXX
     17.0000 .          *
             .XXXXXXXX     *
     50.0000 .           *
             .XXXXXXXX     *
     83.0000 .          *
             .XXXXXXXX    *
    116.0000 .         *
             .      *
    149.0000 .       *
             .XXXXX*XX
    182.0000 .    *
             .X%*XXXXX
    215.0000 .  *
```

FIG. 7.27

```
                STATISTICAL ANALYSIS  GLASS 1Y/2
HISTOGRAM
OFFSET=  0.5
CELL WIDTH =  14
DATA
CONSTANT SUBTRACTED 61
      30.0000
      15.0000
      13.0000
      27.0000
      27.0000
      27.0000
      86.0000
      27.0000
      13.0000
       1.0000

N= 10
MEAN=       39.5000
STD. DEV=       22.5636
SKEWNESS=        1.4413
KURTOSIS=        4.4601
XMIN=        1.0000
XMAX=       86.0000
RANGE=       85.0000

C. VAR.=       25.2175
CELL#    LOWER LIMIT    NO. OF OBS   %RELATIVE FREQ
   1       -6.5000          1          10.00000
   2        7.5000          3          30.00000
   3       21.5000          4          40.00000
   4       35.5000          1          10.00000
   5       49.5000          0           0.00000
   6       63.5000          0           0.00000
   7       77.5000          1          10.00000

EACH X = 1.00  PERCENT

      -6.5000 .      *
              .XXXXXXXXX *
       7.5000 .            *
              .XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
      21.5000 .                                  *
              .XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
      35.5000 .                                  *
              .XXXXXXXXXXX            *
      49.5000 .           *
              .     *
      63.5000 .       *
              .   *
      77.5000 .   *
              .X*XXXXXXXXX
      91.5000 . *
```

FIG. 7.28

STATISTICAL ANALYSIS PAINT 1972

HISTOGRAM
OFFSET= 0.5
CELL WIDTH = 8
DATA
CONSTANT SUBTRACTED 99

1.0000
20.0000
35.0000
27.0000
10.0000
19.0000
52.0000
17.0000
10.0000
13.0000

N= 10
MEAN= 119.9000
STD.DEV= 14.3943
SKEWNESS= 0.7560
KURTOSIS= 2.9053
XMIN= 1.0000
XMAX= 52.0000
RANGE= 51.0000

C.VAR.= 12.0057

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-3.5000	1	10.00000
2	4.5000	2	20.00000
3	12.5000	4	40.00000
4	20.5000	1	10.00000
5	28.5000	1	10.00000
6	36.5000	0	0.00000
7	44.5000	1	10.00000

EACH X = 1.00 PERCENT

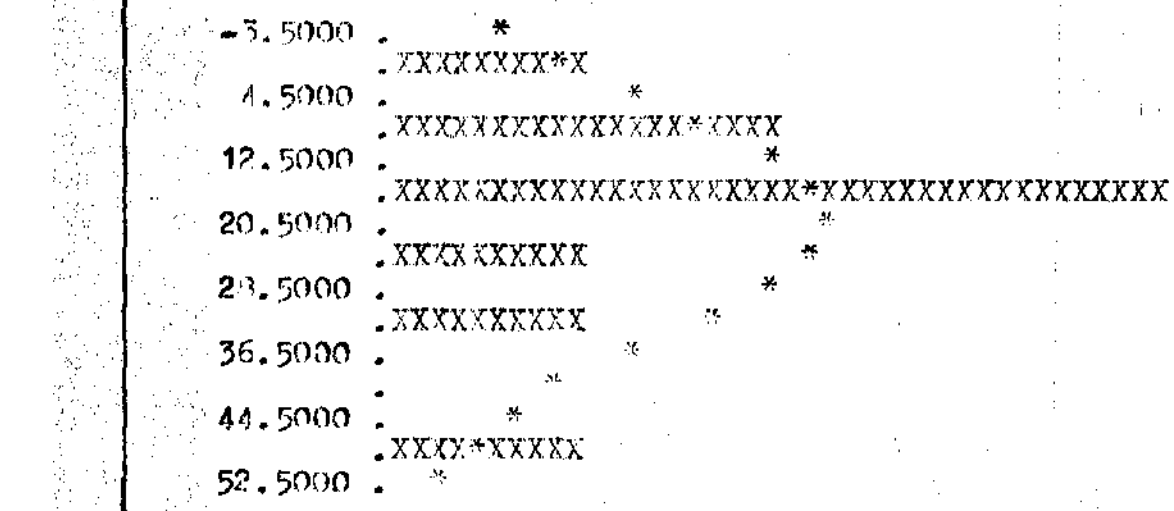


FIG. 7.29

STATISTICAL ANALYSIS FILE: 1972

```
HISTOGRAM
OFFSET=  0.5
CELL WIDTH =  6
DATA
CONSTANT SUBTRACTED 65
      35.0000
      14.0000
       6.0000
      35.0000
      24.0000
      21.0000
      21.0000
       6.0000
       3.0000
       1.0000

N= 10
MEAN=       31.6000
STD.DEV=       12.6069
SKEWNESS=       0.2153
KURTOSIS=       1.3924
XMIN=       1.0000
XMAX=      35.0000
RANGE=      34.0000

C.VAR.=      15.4496
CELL#    LOWER LIMIT    NO. OF OBS   %RELATIVE FREQ
    1      -2.5000          2          20.00000
    2       3.5000          2          20.00000
    3       9.5000          1          10.00000
    4      15.5000          2          20.00000
    5      21.5000          1          10.00000
    6      27.5000          0           0.00000
    7      33.5000          2          20.00000

EACH X = 0.50  PERCENT

 -2.5000 .          *
         .XXXXXXXXXXXXXXXXX*XXXXXXXXXXXXXXXXXXXX
  3.5000 .                *
         .XXXXXXXXXXXXXXXXXXXXXXXXXXX*XXXXXXXXXX
  9.5000 .                           *
         .XXXXXXXXXXXXXXXXXXX                 *
 15.5000 .                                     *
         .XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX*X
 21.5000 .                                    *
         .XXXXXXXXXXXXXXXXXXX            *
 27.5000 .                        *
         .                  *
 33.5000 .            *
         .XXXXXXXXXXX*XXXXXXXXXXXXXXXXXXXXXXXXXX
 39.5000 .      *
```

FIG. 7.30

STATISTICAL ANALYSIS CEMENT 1973

HISTOGRAM
OFFSET= 0.5
CELL WIDTH = 13
DATA
CONSTANT SUBTRACTED 99

1.0000
1.0000
24.0000
45.0000
9.0000
65.0000
30.0000
55.0000
4.0000
4.0000

N= 10
MEAN= 12[illegible].3000
STD.DEV= 29.9474
SKEWNESS= 0.4563
KURTOSIS= 1.3960
XMIN= 1.0000
XMAX= 80.0000
RANGE= 79.0000

C.VAR.= 23.4330

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-6.0000	4	40.00000
2	7.0000	1	10.00000
3	20.0000	1	10.00000
4	33.0000	1	10.00000
5	46.0000	1	10.00000
6	59.0000	1	10.00000
7	72.0000	1	10.00000

EACH X = 1.00 PERCENT

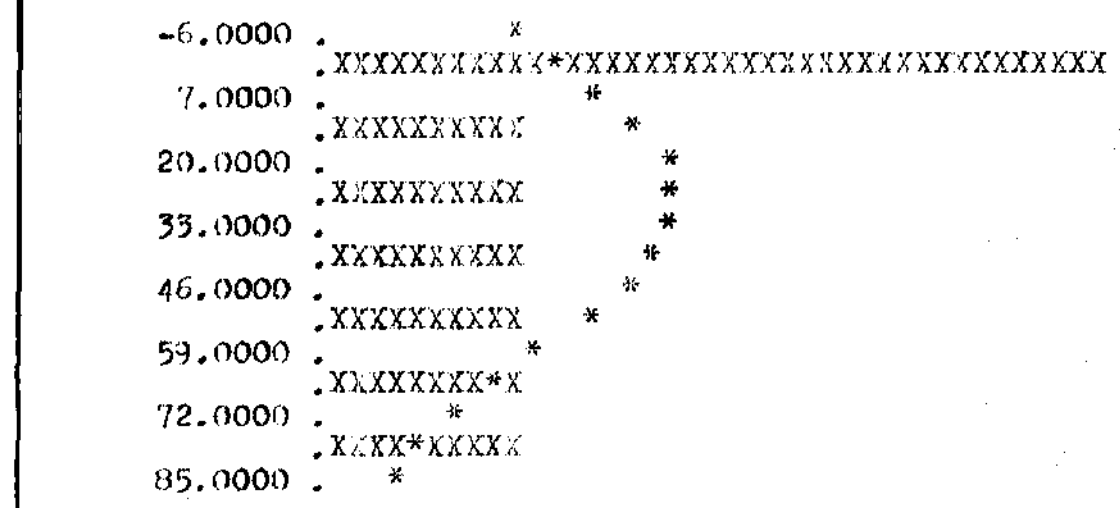


FIG. 7.31

STATISTICAL ANALYSIS 12mm. ROD 1973

HISTOGRAM
OFFSET= 0.5
CELL WIDTH = 21
DATA
CONSTANT SUBTRACTED 99

1.0000
101.0000
31.0000
14.0000
36.0000
34.0000
126.0000
5.0000
33.0000
51.0000

N= 10
MEAN= 147.2000
STD.DEV= 41.3590
SKEWNESS= 0.5719
KURTOSIS= 1.8076
XMIN= 1.0000
XMAX= 126.0000
RANGE= 125.0000

C.VAR.= 28.4363

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-10.0000	2	20.00000
2	11.0000	1	10.00000
3	32.0000	4	40.00000
4	53.0000	0	0.00000
5	74.0000	1	10.00000
6	95.0000	1	10.00000
7	116.0000	1	10.00000

EACH X = 1.00 PERCENT



FIG. 7.33

STATISTICAL ANALYSIS TIMBER 1973

HISTOGRAM
OFFSET= 0.5
CELL WIDTH = 6
DATA
CONSTANT SUBTRACTED 62

33.0000
23.0000
1.0000
28.0000
13.0000
23.0000
28.0000
32.0000
13.0000
13.0000

N= 10
MEAN= 33.2000
STD.DEV= 11.0935
SKEWNESS= -0.2334
KURTOSIS= 1.8330
XMIN= 1.0000
XMAX= 38.0000
RANGE= 37.0000

C.VAR.= 13.3336

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-2.5000	1	10.00000
2	3.5000	0	0.00000
3	9.5000	3	30.00000
4	15.5000	0	0.00000
5	21.5000	2	20.00000
6	27.5000	3	30.00000
7	33.5000	1	10.00000

EACH X = 0.75 PERCENT

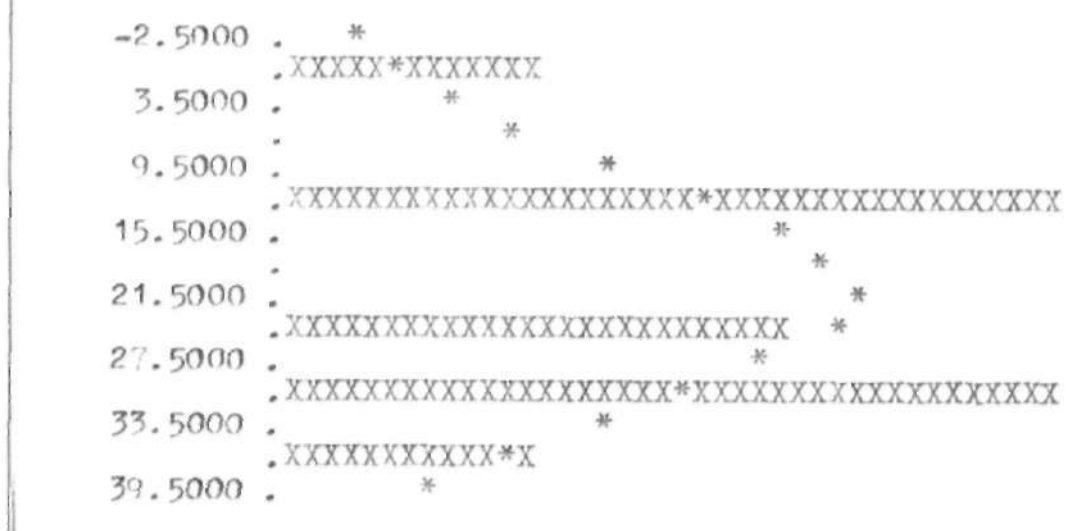


FIG. 7.34

```
                STATISTICAL ANALYSIS HARDBOARD 1973
HISTOGRAM
OFFSET=  0.5
CELL WIDTH =  14
DATA
CONSTANT SUBTRACTED 85
      15.0000
      44.0000
      29.0000
      86.0000
      53.0000
      29.0000
      44.0000
       1.0000
      15.0000
      29.0000

N= 10
MEAN=     120.0000
STD.DEV=      24.3949
SKEWNESS=      0.6222
KURTOSIS=      2.4617
XMIN=        1.0000
XMAX=       86.0000
RANGE=      85.0000

C.VAR.=      20.3291
CELL#    LOWER LIMIT    NO. OF OBS   %RELATIVE FREQ
    1       -6.5000          1          10.00000
    2        7.5000          2          20.00000
    3       21.5000          3          30.00000
    4       35.5000          2          20.00000
    5       49.5000          1          10.00000
    6       63.5000          0           0.00000
    7       77.5000          1          10.00000

EACH X = 0.75  PERCENT

      -6.5000 .       *
              .XXXXXXXXXXX*X
       7.5000 .                *
              .XXXXXXXXXXXXXXXXXXXX*XXXX
      21.5000 .                        *
              .XXXXXXXXXXXXXXXXXXXXXXXXXXXX*XXXXXXXXXX
      35.5000 .                                *
              .XXXXXXXXXXXXXXXXXXXXXXXXXX   *
      49.5000 .                              *
              .XXXXXXXXXXXXX       *
      63.5000 .                 *
              .          *
      77.5000 .       *
              .XXXX*XXXXXXXX
      91.5000 .  *
```

FIG. 7.35

```
HISTOGRAM
OFFSET=  0.5
CELL WIDTH =  12
DATA
CONSTANT SUBTRACTED 99
       1.0000
       1.0000
      11.0000
      26.0000
      76.0000
       1.0000
      51.0000
      16.0000
      11.0000
      26.0000

N= 10
MEAN=     121.0000
STD.DEV=      24.4722
SKEWNESS=      1.0325
KURTOSIS=      2.7313
XMIN=      1.0000
XMAX=     76.0000
RANGE=     75.0000

C.VAR.=     20.2250
CELL#    LOWER LIMIT    NO. OF OBS   %RELATIVE FREQ
    1       -5.5000          3          30.00000
    2        6.5000          3          30.00000
    3       18.5000          2          20.00000
    4       30.5000          0           0.00000
    5       42.5000          1          10.00000
    6       54.5000          0           0.00000
    7       66.5000          1          10.00000

EACH X = 0.25  PERCENT

 -5.5000 .                *
         .XXXXXXXXXXXXXXXXX*XXXXXXXXXXXXXXXXXXX
  6.5000 .                   *
         .XXXXXXXXXXXXXXXXXXXXXXXXX*XXXXXXXXXXXXX
 18.5000 .                      *
         .XXXXXXXXXXXXXXXXXXXXXXXXXX*
 30.5000 .                      *
         .                   *
 42.5000 .                *
         .XXXXXXXXXXXXX   *
 54.5000 .             *
         .       *
 66.5000 .     *
         .XXX*XXXXXXXXX
 78.5000 .   *
```

FIG. 7.36

STATISTICAL ANALYSIS ASBESTOS 1973

HISTOGRAM
OFFSET= 0.5
CELL WIDTH = 20
DATA
CONSTANT SUBTRACTED 49

51.0000
32.0000
120.0000
70.0000
51.0000
39.0000
1.0000
51.0000
45.0000
45.0000

N= 10
MEAN= 99.5000
STD.DEV= 30.1732
SKEWNESS= 0.7773
KURTOSIS= 3.5707
XMIN= 1.0000
XMAX= 120.0000
RANGE= 119.0000

C.VAR.= 30.3293

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-9.5000	1	10.00000
2	10.5000	0	0.00000
3	30.5000	4	40.00000
4	50.5000	4	40.00000
5	70.5000	0	0.00000
6	90.5000	0	0.00000
7	110.5000	1	10.00000

EACH X = 1.00 PERCENT

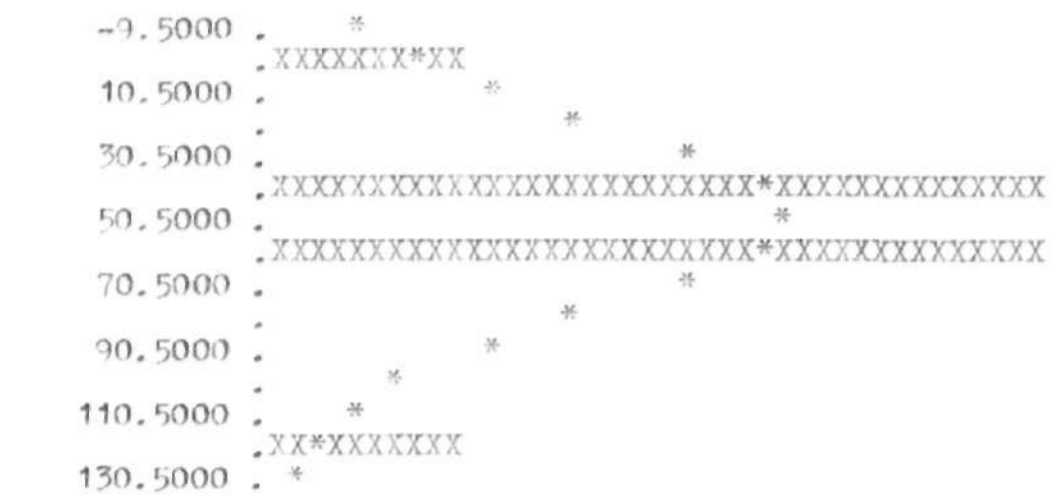


FIG. 7.37

```
                STATISTICAL ANALYSIS  ALGORITHM 1973
HISTOGRAM
OFFSET=  0.5
CELL WIDTH =  9
DATA
CONSTANT SUBTRACTED 65
      35.0000
      35.0000
       1.0000
      34.0000
      35.0000
      35.0000
      56.0000
      33.0000
      41.0000
      56.0000

N= 10
MEAN=      101.6000
STD. DEV=       15.1232
SKEWNESS=       -0.3807
KURTOSIS=        3.6131
XMIN=         1.0000
XMAX=        56.0000
RANGE=       55.0000

C. VAR.=        14.8850

CELL#    LOWER LIMIT    NO. OF OBS   %RELATIVE FREQ
    1       -4.0000          1          10.00000
    2        5.0000          0           0.00000
    3       14.0000          0           0.00000
    4       23.0000          0           0.00000
    5       32.0000          6          60.00000
    6       41.0000          1          10.00000
    7       50.0000          2          20.00000

EACH X = 1.50  PERCENT

      -4.0000 .*
              .X*XXXX
       5.0000 .  *
              .  *
      14.0000 .     *
              .     *
      23.0000 .        *
              .        *
      32.0000 .           *
              .XXXXXXXXXXXXXX*XXXXXXXXXXXXXXXXXXXXXXX
      41.0000 .           *
              .XXXXXX        *
      50.0000 .              *
              .XXXXXXXX*XXXX
      59.0000 .     *
```

FIG. 7.38

STATISTICAL ANALYSIS CLASS 1973

HISTOGRAM
OFFSET= 0.5
CELL WIDTH = 13
DATA
CONSTANT SUBTRACTED 57

43.0000
11.0000
17.0000
22.0000
31.0000
40.0000
90.0000
23.0000
22.0000
11.0000

N= 10
MEAN= 88.5000
STD.DEV= 23.2630
SKEWNESS= 1.4322
KURTOSIS= 4.1432
XMIN= 11.0000
XMAX= 90.0000
RANGE= 79.0000

C.VAR.= 26.2359

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-6.0000	0	0.00000
2	7.0000	3	30.00000
3	20.0000	4	40.00000
4	33.0000	2	20.00000
5	46.0000	0	0.00000
6	59.0000	0	0.00000
7	72.0000	0	0.00000
8	85.0000	1	10.00000

EACH X = 1.00 PERCENT

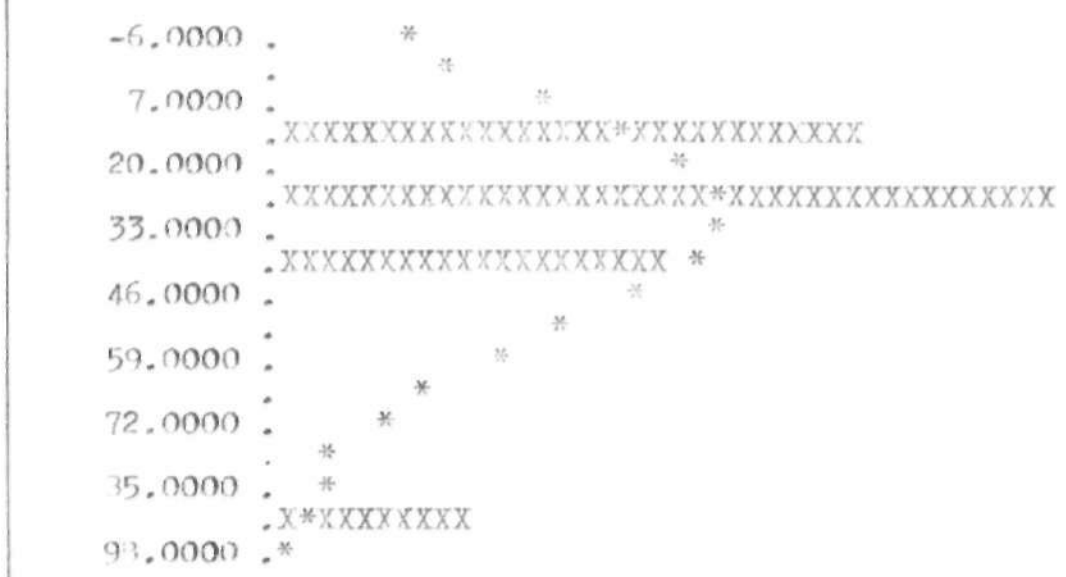


FIG. 7.39

STATISTICAL ANALYSIS PAINT 1973

```
HISTOGRAM
OFFSET=  0.5
CELL WIDTH =  8
DATA
CONSTANT SUBTRACTED 38
      12.0000
      25.0000
       1.0000
      25.0000
      27.0000
      29.0000
      46.0000
      25.0000
      26.0000
      25.0000

N=  10
MEAN=      112.1000
STD.DEV=       11.5417
SKEWNESS=      -0.2239
KURTOSIS=       3.0254
XMIN=        1.0000
XMAX=       46.0000
RANGE=       45.0000

C.VAR.=       10.2959
```

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-3.5000	1	10.00000
2	4.5000	1	10.00000
3	12.5000	0	0.00000
4	20.5000	6	60.00000
5	28.5000	1	10.00000
6	36.5000	0	0.00000
7	44.5000	1	10.00000

EACH X = 1.50 PERCENT

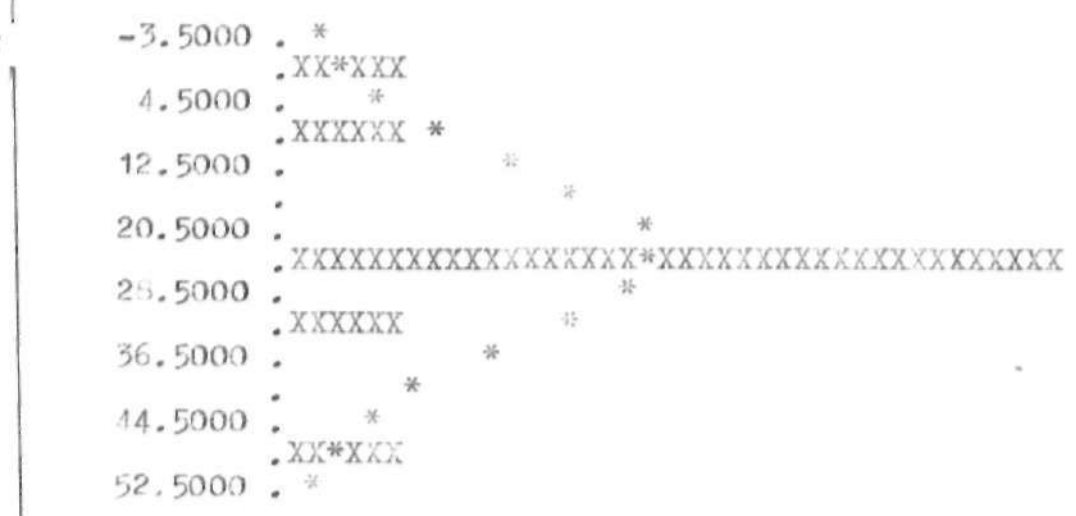


FIG. 7.40

STATISTICAL ANALYSIS TILES 1973

```
HISTOGRAM
OFFSET=  0.5
CELL WIDTH =  14
DATA
CONSTANT SUBTRACTED 76
      24.0000
      29.0000
      -1.0000
      27.0000
      24.0000
      32.0000
      61.0000
      40.0000
      50.0000
      29.0000

N= 10
MEAN=      112.5000
STD.DEV=      25.0615
SKEWNESS=      0.4326
KURTOSIS=      2.3760
XMIN=      -1.0000
XMAX=      82.0000
RANGE=      83.0000

C.VAR.=      20.4901
CELL#    LOWER LIMIT    NO. OF OBS   %RELATIVE FREQ
    1      -6.5000          1          10.00000
    2       7.5000          0           0.00000
    3      21.5000          5          50.00000
    4      35.5000          1          10.00000
    5      49.5000          2          20.00000
    6      63.5000          0           0.00000
    7      77.5000          1          10.00000

EACH X = 1.25  PERCENT

      -6.5000 .    *
              .XXXXXX*X
       7.5000 .         *
              .           *
      21.5000 .                *
              .XXXXXXXXXXXXXXXXX*XXXXXXXXXXXXXXXXXXXXX
      35.5000 .                  *
              .XXXXXXXX           *
      49.5000 .                 *
              .XXXXXXXXXXXXX*XX
      63.5000 .           *
              .      *
      77.5000 .     *
              .XX*XXXXX
      91.5000 . *
```

FIG. 7.41

STATISTICAL ANALYSIS CEMENT 1974

HISTOGRAM
OFFSET= 0.5
CELL WIDTH = 20
DATA
CONSTANT SUBTRACTED 99

1.0000
60.0000
115.0000
37.0000
96.0000
106.0000
110.0000
73.0000
74.0000

N= 9
MEAN= 174.2222
STD.DEV= 37.7136
SKEWNESS= -0.6732
KURTOSIS= 2.0633
XMIN= 1.0000
XMAX= 115.0000
RANGE= 114.0000

C.VAR.= 21.6497

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-9.5000	1	11.11111
2	10.5000	0	0.00000
3	30.5000	1	11.11111
4	50.5000	1	11.11111
5	70.5000	2	22.22222
6	90.5000	3	33.33333
7	110.5000	1	11.11111

EACH X = 0.83 PERCENT

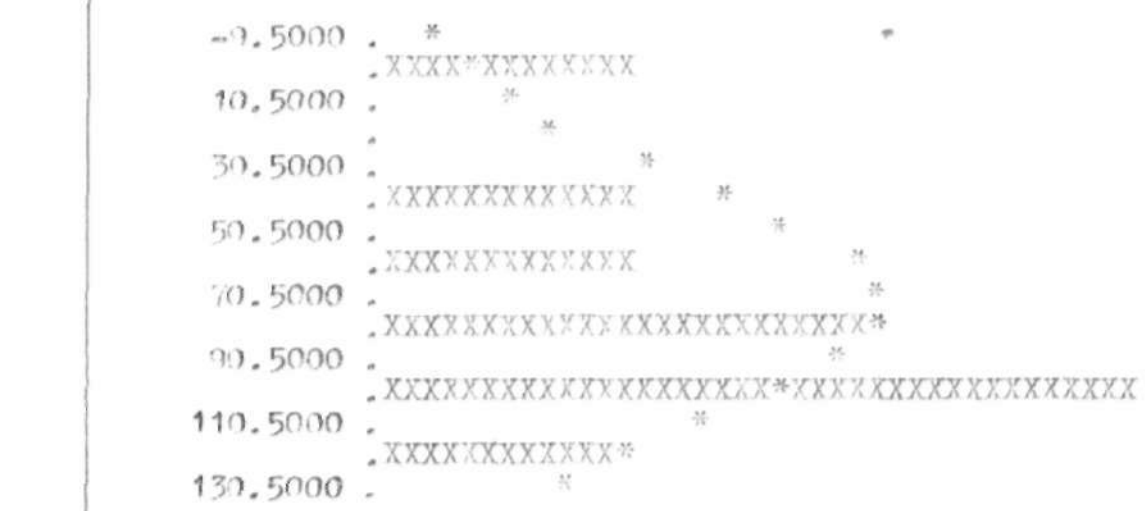


FIG. 7.42

```
                STATISTICAL ANALYSISROD 1974
HISTOGRAM
OFFSET=  0.5
CELL WIDTH =  19
DATA
CONSTANT SUBTRACTED 99
       1.0000
       6.0000
      41.0000
      47.0000
      32.0000
      13.0000
      34.0000
       9.0000
     112.0000

N= 9
MEAN=     132.3333
STD. DEV=      33.6452
SKEWNESS=       1.2133
KURTOSIS=       3.5024
XMIN=       1.0000
XMAX=     112.0000
RANGE=     111.0000

C.VAR.=      25.4246
CELL#    LOWER LIMIT    NO. OF OBS   %RELATIVE FREQ
    1      -9.0000            3          33.33333
    2      10.0000            1          11.11111
    3      29.0000            4          44.44444
    4      48.0000            0           0.00000
    5      67.0000            0           0.00000
    6      86.0000            0           0.00000
    7     105.0000            1          11.11111
```

```
EACH X = 1.11  PERCENT

     -9.0000 .          *
             .XXXXXXXXXXXX*XXXXXXXXXXXXXXXX
     10.0000 .                *
             .XXXXXXXXXX            *
     29.0000 .                       *
             .XXXXXXXXXXXXXXXXXXXX*XXXXXXXXXXXXXXXXXXXX
     48.0000 .                          *
             .                     *
     67.0000 .               *
             .           *
     86.0000 .       *
             .    *
    105.0000 .   *
             .X*XXXXXXXX
    124.0000 . *
```

FIG. 7.43

STATISTICAL ANALYSIS TIMBER 1974

HISTOGRAM
OFFSET= 0.5
CELL WIDTH = 33
DATA
CONSTANT SUBTRACTED 99

1.0000
134.0000
1.0000
201.0000
34.0000
63.0000
56.0000
63.0000
16.0000

N= 9
MEAN= 163.3333
STD.DEV= 66.0549
SKEWNESS= 0.8641
KURTOSIS= 2.3331
XMIN= 1.0000
XMAX= 201.0000
RANGE= 200.0000

C.VAR.= 40.4413

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-16.0000	3	33.33333
2	17.0000	1	11.11111
3	50.0000	3	33.33333
4	83.0000	0	0.00000
5	116.0000	1	11.11111
6	149.0000	0	0.00000
7	182.0000	1	11.11111

EACH X = 0.83 PERCENT

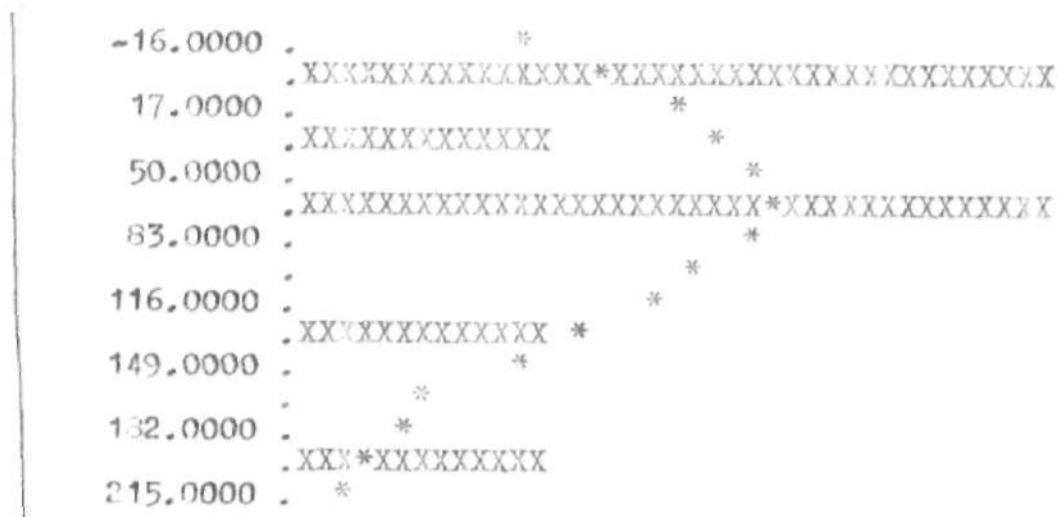


FIG. 7.44

STATISTICAL ANALYSIS HARDBOARD 1974

HISTOGRAM
OFFSET= 0.5
CELL WIDTH = 25
DATA
CONSTANT SUBTRACTED 40

51.0000
84.0000
1.0000
113.0000
13.0000
134.0000
151.0000
84.0000
63.0000

N= 9
MEAN= 127.7773
STD. DEV= 50.6032
SKEWNESS= -0.0960
KURTOSIS= 1.5193
XMIN= 1.0000
XMAX= 151.0000
RANGE= 150.0000

C.VAR.= 39.6065

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-12.0000	1	11.11111
2	13.0000	1	11.11111
3	38.0000	1	11.11111
4	63.0000	3	33.33333
5	88.0000	0	0.00000
6	113.0000	2	22.22222
7	138.0000	1	11.11111

EACH X = 0.83 PERCENT



FIG. 7.45

STATISTICAL ANALYSIS - [illegible] 1974

HISTOGRAM
OFFSET= 0.5
CELL WIDTH = 10
DATA
CONSTANT SUBTRACTED 60

40.0000
13.0000
25.0000
50.0000
1.0000
13.0000
13.0000
60.0000
8.0000

N= 9
MEAN= 34.7771
STD.DEV= 20.5291
SKEWNESS= 0.5163
KURTOSIS= 1.5362
MIN= 1.0000
MAX= 60.0000
RANGE= 59.0000

C.VAR.= 24.2152

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-4.5000	1	11.11111
2	5.5000	4	44.44444
3	15.5000	1	11.11111
4	25.5000	0	0.00000
5	35.5000	1	11.11111
6	45.5000	1	11.11111
7	55.5000	1	11.11111

EACH X = 1.11 PERCENT



Fig. 7.46

```
          STATISTICAL ANALYSIS  ARGUMENT NO.4
HISTOGRAM
OFFSET=  0.5
CELL WIDTH =  12
DATA
CONSTANT SUBTRACTED 56
      44.0000
       1.0000
      65.0000
      51.0000
      65.0000
      94.0000
      65.0000
      51.0000
      37.0000

N= 9
MEAN=      101.5556
STD.DEV=       25.3914
SKEWNESS=       -0.4372
KURTOSIS=        2.7100
XMIN=         1.0000
X  AX=       94.0000
RANGE=       93.0000

C.VAR.=       23.3953

CELL#    LOWER LIMIT    NO. OF OBS   %RELATIVE FREQ
   1       -5.5000          1          11.11111
   2        6.5000          0           0.00000
   3       18.5000          0           0.00000
   4       30.5000          1          11.11111
   5       42.5000          3          33.33333
   6       54.5000          3          33.33333
   7       66.5000          0           0.00000
   8       78.5000          0           0.00000
   9       90.5000          1          11.11111

EACH X = 0.33  PERCENT

    -5.5000 .  *
            .XXX*XXXXXXXXX
     6.5000 .    *
            .      *
            .
    18.5000 .         *
            .           *
    30.5000 .             *
            .XXXXXXXXXXXXX      *
    42.5000 .                     *
            .XXXXXXXXXXXXXXXXXXXXXX*XXXXXXXXXXXXXXXXX
    54.5000 .                       *
            .XXXXXXXXXXXXXXXXXXXXXXX*XXXXXXXXXXXXXXXX
    66.5000 .                         *
            .                           *
    78.5000 .                             *
            .                               *
    90.5000 .                         *
            .XXXXX*XXXXXXX
   102.5000 .    *
```

FIG. 7.47

```
          STATISTICAL ANALYSIS    ALUMINIUM 1974
HISTOGRAM
OFFSET=  0.5
CELL WIDTH =  7
DATA
CONSTANT SUBTRACTED 85
      15.0000
      40.0000
     -10.0000
      18.0000
      35.0000
      43.0000
      29.0000
       1.0000
       7.0000

N= 9
MEAN=      104.7778
STD.DEV=       13.3492
SKEWNESS=      -0.1320
KURTOSIS=       1.4273
XMIN=     -10.0000
XMAX=      43.0000
RANGE=      53.0000

C.VAR.=       17.5125
NO. TOO SMALL= 1

CELL#    LOWER LIMIT    NO. OF OBS   %RELATIVE FREQ
    1      -3.0000          1          11.11111
    2       4.0000          1          11.11111
    3      11.0000          1          11.11111
    4      18.0000          1          11.11111
    5      25.0000          1          11.11111
    6      32.0000          1          11.11111
    7      39.0000          2          22.22222

EACH X = 0.56  PERCENT

     -3.0000 .          *
             .XXXXXXXXXXXXXXXX*XXX
      4.0000 .                *
             .XXXXXXXXXXXXXXXXXXX  *
     11.0000 .                     *
             .XXXXXXXXXXXXXXXXXXXX      *
     18.0000 .                       *
             .XXXXXXXXXXXXXXXXXXXX      *
     25.0000 .                      *
             .XXXXXXXXXXXXXXXXXXX    *
     32.0000 .                   *
             .XXXXXXXXXXXXXXXXXXX*
     39.0000 .                 *
             .XXXXXXXXXXXX*XXXXXXXXXXXXXXXXXXXXXXXXXXXX
     46.0000 .           *
```

FIG. 7.48

```
                    STATISTICAL ANALYSIS CLASS 1974
HISTOGRAM
OFFSET=  0.5
CELL WIDTH =  24
DATA
CONSTANT SUBTRACTED 37
      13.0000
       1.0000
     143.0000
      60.0000
      93.0000
       1.0000
      31.0000
      39.0000
       1.0000

N= 9
MEAN=     136.1111
STD.DEV=       52.9333
SKEWNESS=       0.5690
KURTOSIS=       1.7173
   N=        1.0000
XMAX=     143.0000
RANGE=    147.0000

C.VAR.=       38.9239

CELL#    LOWER LIMIT    NO. OF OBS  %RELATIVE FREQ
   1      -11.5000          3          33.33333
   2       12.5000          2          22.22222
   3       36.5000          1          11.11111
   4       60.5000          0           0.00000
   5       84.5000          2          22.22222
   6      108.5000          0           0.00000
   7      132.5000          1          11.11111


EACH X = 0.83  PERCENT

   -11.5000 .          *
            .XXXXXXXXXXXXXX*XXXXXXXXXXXXXXXXXXXXXXXXX
    12.5000 .             *
            .XXXXXXXXXXXXXXXXXXXX*XXXXXX
    36.5000 .                   *
            .XXXXXXXXXXXXXX       *
    60.5000 .                  *
            .                *
            .              *
    84.5000 .            *
            .XXXXXXXXXXXXXXX*XXXXXXXXXX
   108.5000 .             *
            .          *
   132.5000 .       *
            .XXXX*XXXXXXXX
   156.5000 .    *
```

FIG. 7.49

STATISTICAL ANALYSIS PAINT 1974

HISTOGRAM
OFFSET= 0.5
CELL WIDTH = 9
DATA
CONSTANT SUBTRACTED 63

37.0000
53.0000
25.0000
52.0000
47.0000
53.0000
54.0000
23.0000
1.0000

N= 9
MEAN= 103.0000
STD.DEV= 19.1572
SKEWNESS= -0.7531
KURTOSIS= 2.1914
MIN= 1.0000
MAX= 58.0000
RANGE= 57.0000

C.VAR.= 18.5993

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-4.0000	1	11.11111
2	5.0000	0	0.00000
3	14.0000	0	0.00000
4	23.0000	2	22.22222
5	32.0000	1	11.11111
6	41.0000	1	11.11111
7	50.0000	4	44.44444

EACH X = 1.11 PERCENT

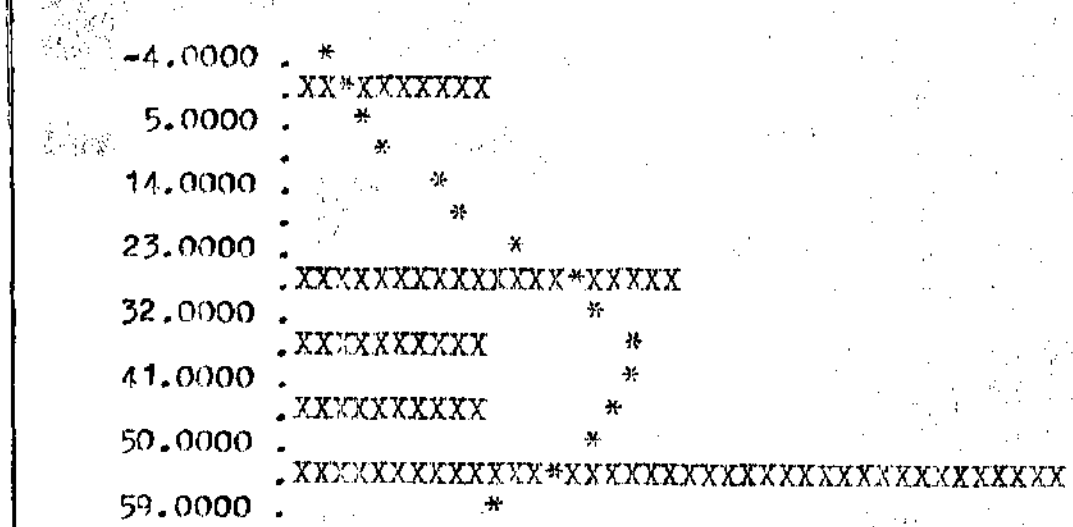


FIG. 7.50

STATISTICAL ANALYSIS TIDES 1974

HISTOGRAM
OFFSET= 0.5
CELL WIDTH = 7
DATA
CONSTANT SUBTRACTED 99

1.0000
26.0000
43.0000
18.0000
34.0000
43.0000
26.0000
34.0000
18.0000

N= 9
MEAN= 126.0000
STD.DEV= 13.4629
SKEWNESS= -0.4625
KURTOSIS= 2.0405
XMIN= 1.0000
XMAX= 43.0000
RANGE= 42.0000

C.VAR.= 10.6849

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-3.0000	1	11.11111
2	4.0000	0	0.00000
3	11.0000	0	0.00000
4	18.0000	2	22.22222
5	25.0000	2	22.22222
6	32.0000	2	22.22222
7	39.0000	2	22.22222

EACH X = 0.56 PERCENT

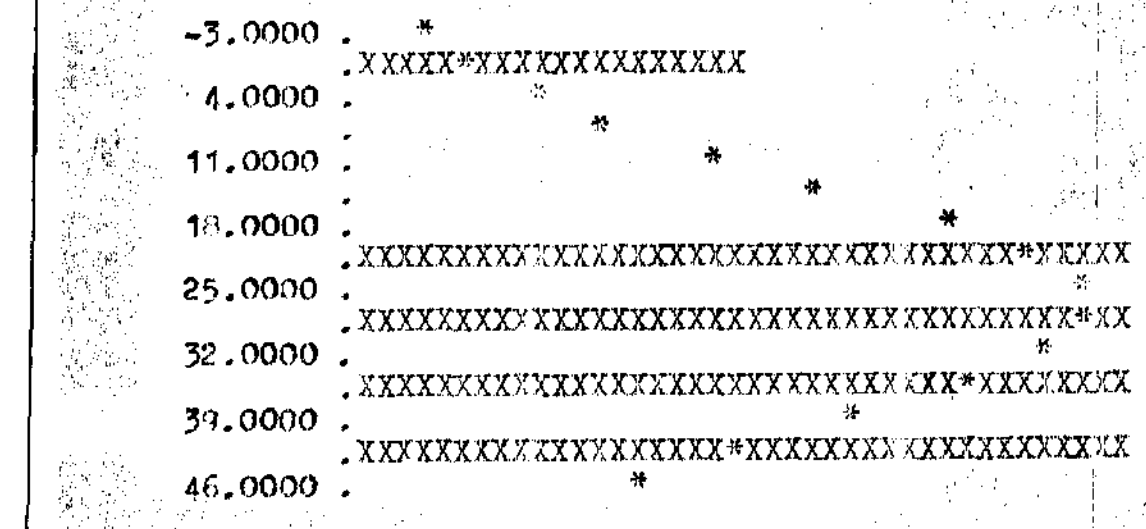


FIG. 7.51

SUMMARY STATISTICAL ANALYSIS BUILDING MATERIALS

	ITEM	YEAR	NO. IN SAMPLE	MEAN	STD.DEV.	SKEW	KURT.	RANGE	C.VAR
1.	Cement	1972	10	125.40	25.769	0.760	2.296	79.00	20.550
2.	19 mm Aggregate	1972	10	93.00	15.670	-2.005	5.698	50.00	16.850
3.	12 mm Mild Steel rod	1972	10	107.40	24.573	1.123	3.029	82.00	22.880
4.	Timber	1972	10	87.40	7.806	-0.312	2.010	25.00	8.931
5.	Hardboard	1972	10	122.80	56.326	1.685	4.905	200.00	45.868
6.	Blocks	1972	10	183.40	63.858	0.331	1.515	192.00	34.819
7.	Asbestos roof sheets	1972	10	73.00	21.879	0.007	1.423	59.00	29.971
8.	Aluminium roof sheets	1972	10	154.60	75.111	0.886	2.048	202.00	48.584
9.	Glass	1972	10	89.50	22.570	1.441	4.460	85.00	25.218
10.	Paint	1972	10	119.90	14.395	0.756	2.706	51.00	12.006
11.	Tiles	1972	10	81.60	12.607	0.216	1.392	34.00	15.450
12.	Cement	1973	10	127.80	29.947	0.456	1.397	79.00	23.433
13.	19 mm Aggregate	1973	10	96.00	12.649	-2.277	6.570	40.00	13.176
14.	12 mm Rod	1973	10	147.20	41.859	0.572	1.808	125.00	28.437
15.	Timber	1973	10	83.20	11.094	-0.238	1.833	37.00	13.334
16.	Hardboard	1973	10	120.00	24.395	0.622	2.462	85.00	20.329
17.	Blocks	1973	10	121.00	24.472	1.033	2.739	75.00	20.225
18.	Asbestos roof sheets	1973	10	99.50	30.178	0.777	3.571	119.00	30.330
19.	Aluminium roof sheets	1973	10	101.60	15.123	-0.881	3.613	55.00	14.885
20.	Glass	1973	10	88.50	23.263	1.432	4.148	79.00	26.286
21.	Paint	1973	10	112.10	11.542	-0.224	3.025	45.00	10.296
22.	Tiles	1973	10	112.50	23.062	0.433	2.376	83.00	20.499

FIG. 7.52

BUILDING MATERIALS: LOCATION INDICES (contd.)

	ITEM	YEAR	NO. IN SAMPLE	MEAN	STD.DEV.	SKEW	KURT	RANGE	C.VAR.
23.	Cement	1974	9	174.22	37.719	-0.673	2.063	114.00	21.650
24.	12 mm Mild Steel rod	1974	9	132.33	33.645	1.218	3.502	111.00	25.425
25.	Timber	1974	9	163.33	66.055	0.864	2.398	200.00	40.442
26.	Hardboard	1974	9	127.78	50.608	- 0.096	1.520	150.00	39.607
27.	Blocks	1974	9	84.78	20.519	0.516	1.535	59.00	24.215
28.	Asbestos roof sheets	1974	9	108.56	25.397	-0.437	2.711	93.00	23.396
29.	Aluminium roof sheets	1974	9	104.78	18.349	-0.182	1.428	53.00	17.513
30.	Glass	1974	9	136.11	53.980	0.569	1.717	147.00	38.924
31.	Paint	1974	9	103.00	19.157	-0.758	2.191	57.00	18.599
32.	Tiles	1974	9	126.00	13.463	-0.463	2.050	42.00	10.685

FIG. 7.52

TIME SCALE : RANGES

YEAR	INDEX
I.D.A. Historical Method	
1967	100
1968	113
1969	103
1970	90
Unit Rate Method	
1972	100
1973	114
1974	126

FIG. 7.53

BUILDING MATERIALS

TIME SCALES 1972 -- 1974

MATERIAL		LAGOS	IBADAN	ILORIN	KADUNA	BENIN	M/GURI	SOKOTO	KANO	JOS	ENUGU
Cement	1972	100	100	100	100	100	100	100	100	100	100
	1973	100	100	100	119	100	119	100	120	67	100
	1974	113	-	146	199	143	159	129	184	-	195
12 mm Dia M.S. rod	1972	100	100	100	100	100	100	100	100	100	100
	1973	83	182	92	90	108	108	137	100	106	154
	1974	143	-	92	192	200	182	122	219	-	190
Timber	1972	100	100	100	100	100	100	100	100	100	100
	1973	120	120	83	120	120	120	120	120	100	120
	1974	75	-	194	83	300	118	139	123	-	167
450x225x225 mm Blocks	1972	100	100	100	100	100	100	100	100	100	100
	1973	167	133	88	125	100	100	100	128	73	167
	1974	342	-	120	175	129	125	100	167	-	327
Asbestos roofing	1972	100	100	100	100	100	100	100	100	100	100
	1973	94	100	225	112	94	117	114	178	188	125
	1974	82	-	67	100	88	142	300	189	-	125
Aluminium roofing	1972	100	100	100	100	100	100	100	100	100	100
	1973	151	75	66	149	151	151	60	146	61	149
	1974	142	-	118	107	147	171	60	152	-	100

FIG. 7.54

LOCATION INDEX CLASSROOMS 1969

ELEMENTAL ANALYSIS

LOCATION	TOTAL	T. – SUBSTRUCTURE	T. – FRAME	T. – ROOF	T. – EXT.W.	T. – INT.W.	T. – F. & F.	T. – SERVICES
1. Kano COST	59.74	49.30	58.12	33.15	52.31	52.53	57.69	55.34
INDEX	134	.143		105	136	140	147	130
2. Sabongida Ora	44.46	33.16	–	31.44	38.43	37.57	39.29	42.41
	100	100		100	100	100	100	100
3. Sapele	45.67	35.71	–	35.36	37.89	37.52	37.52	44.35
	103	108		112	99	100	95	105
4. Benin	49.51	44.45	–	44.34	38.75	38.31	42.19	46.08
	111	134	–	141	101	102	107	109
5. Ilorin	53.37	39.57	–	35.60	44.88	44.28	52.36	50.16
	120	119		113	117	118	133	118
6. Okene	61.24	49.94	–	43.19	37.40	58.54	58.79	58.34
	138	151		137	97	156	150	138
7. Zaria	60.90	53.37	–	36.73	44.26	56.53	56.85	56.76
	137	161		117	115	150	145	134
8. Makurdi	48.33	38.14	–	39.37	28.36	44.45	45.02	46.31
	109	115		125	74	118	115	109
9. Ijebu-Ode	47.72	38.34	–	31.75	37.34	44.44	46.46	40.27
	107	116		101	97	118	118	95
10. Lagos	44.46	33.16	–	31.44	38.43	37.57	39.29	42.41
	100	100		100	100	100	100	100
C. VAR INDEX	13.183	17.458	–	13.025	15.685	17.825	17.501	13.524

FIG. 7.55

STATISTICAL ANALYSIS CL. 1969 T-SU.

HISTOGRAM

OFFSET= 0.5

CELL WIDTH = 10

DATA

CONSTANT SUBTRACTED 60

87.0000
40.0000
48.0000
74.0000
59.0000
91.0000
101.0000
55.0000
56.0000
40.0000

N= 10

MEAN= 125.1000

STD. DEV= 21.8401

SKEWNESS= 0.3476

KURTOSIS= 1.4264

XMIN= 40.0000

XMAX= 101.0000

RANGE= 61.0000

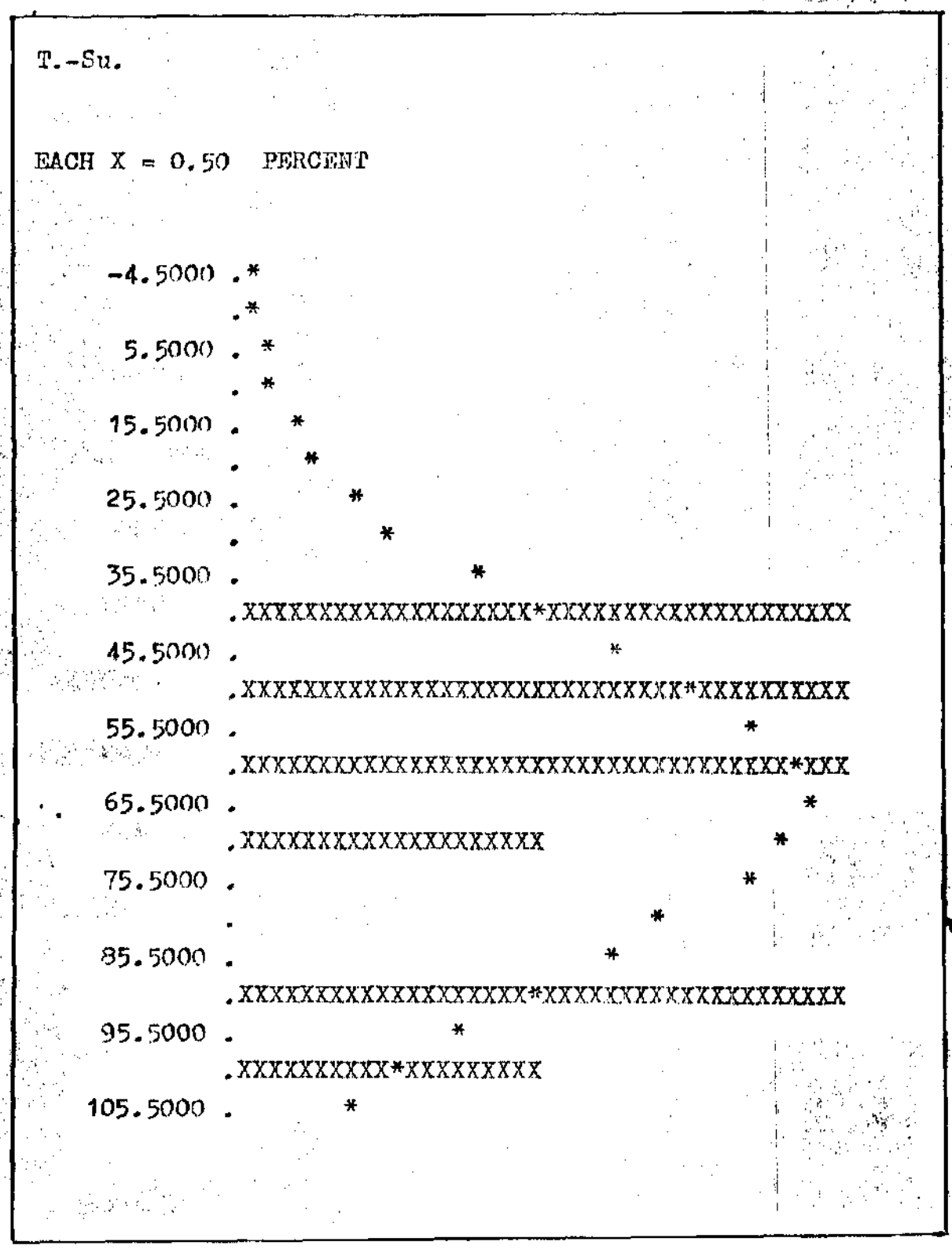
C. VAR. = 17.4581

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-4.5000	0	0.00000
2	5.5000	0	0.00000
3	15.5000	0	0.00000
4	25.5000	0	0.00000
5	35.5000	2	20.00000
6	45.5000	2	20.00000
7	55.5000	2	20.00000
8	65.5000	1	10.00000
9	75.5000	0	0.00000
10	85.5000	2	20.00000
11	95.5000	1	10.00000

Fig. 7.56

T.-Su.

EACH X = 0.50 PERCENT



STATISTICAL ANALYSIS CL.1969 T-R.

HISTOGRAM

OFFSET= 0.5

CELL WIDTH = 7

DATA

CONSTANT SUBTRACTED 90

15.0000
10.0000
22.0000
51.0000
23.0000
47.0000
27.0000
35.0000
11.0000
10.0000

N= 10
MEAN= 115.1000
STD.DEV= 14.9922
SKEWNESS= 0.5370
KURTOSIS= 1.6699
XMIN= 10.0000
XMAX= 51.0000
RANGE= 41.0000

C.VAR.= 13.0254

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-3.0000	0	0.00000
2	4.0000	2	20.00000
3	11.0000	2	20.00000
4	18.0000	2	20.00000
5	25.0000	1	10.00000
6	32.0000	1	10.00000
7	39.0000	0	0.00000
8	46.0000	2	20.00000

FIG. 7.58

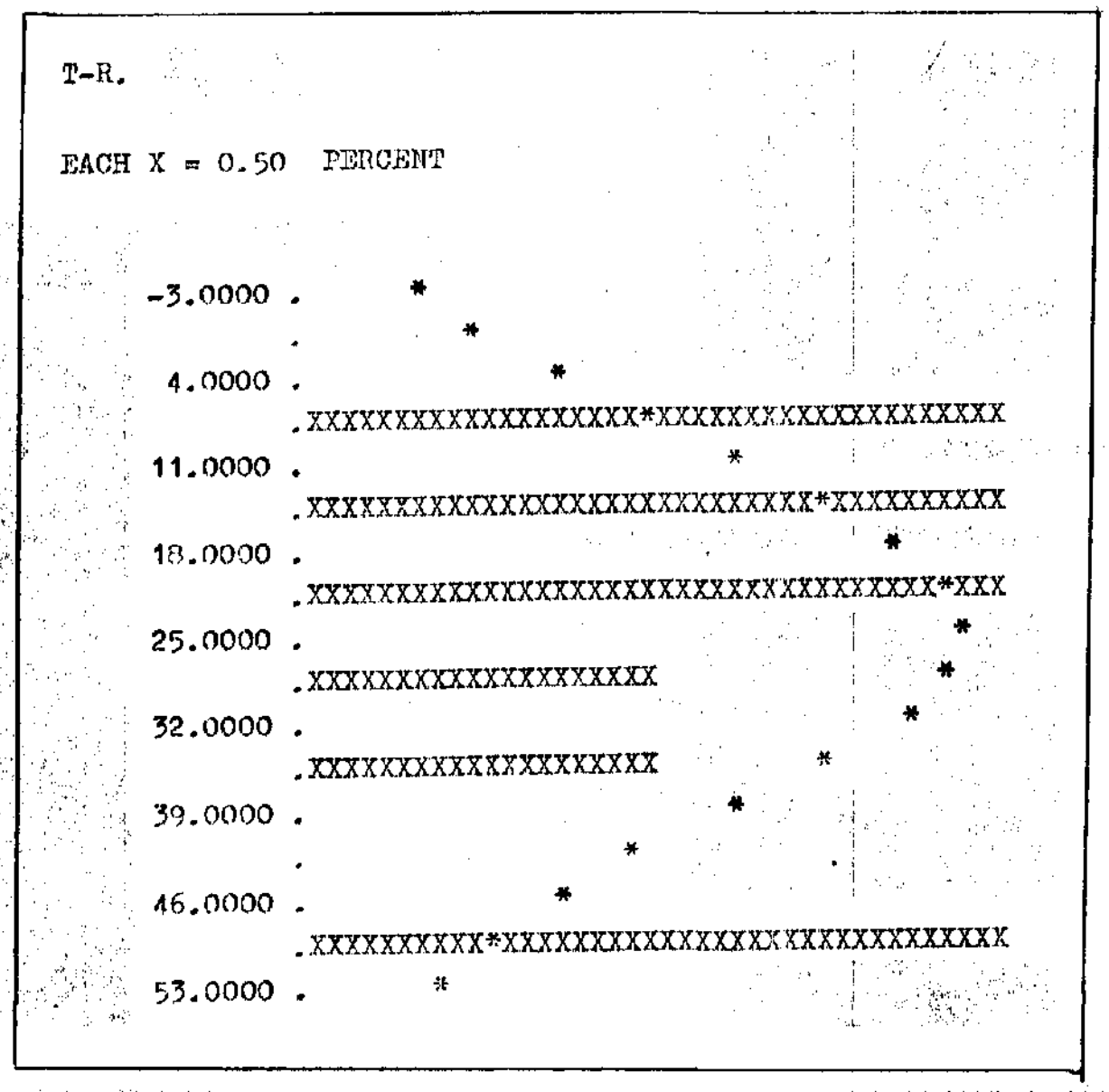

T-R.
EACH X = 0.50 PERCENT
-3.0000
4.0000
11.0000
18.0000
25.0000
32.0000
39.0000
46.0000
53.0000

FIG. 7.59

STATISTICAL ANALYSIS . CL. 1969 F-E.U.

HISTOGRAM

OFFSET= 0.5

CELL WIDTH = 10

DATA

CONSTANT SUBTRACTED 65

71.0000
35.0000
34.0000
36.0000
52.0000
32.0000
50.0000
9.0000
32.0000
35.0000

N= 10

MEAN= 103.6000

STD.DEV= 16.2494

SKEWNESS= 0.2606

KURTOSIS= 2.7588

XMIN= 9.0000

XMAX= 71.0000

RANGE= 62.0000

C.VAR.= 15.6848

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-4.5000	0	0.00000
2	5.5000	1	10.00000
3	15.5000	0	0.00000
4	25.5000	5	50.00000
5	35.5000	1	10.00000
6	45.5000	2	20.00000
7	55.5000	0	0.00000
8	65.5000	1	10.00000

FIG. 7.60

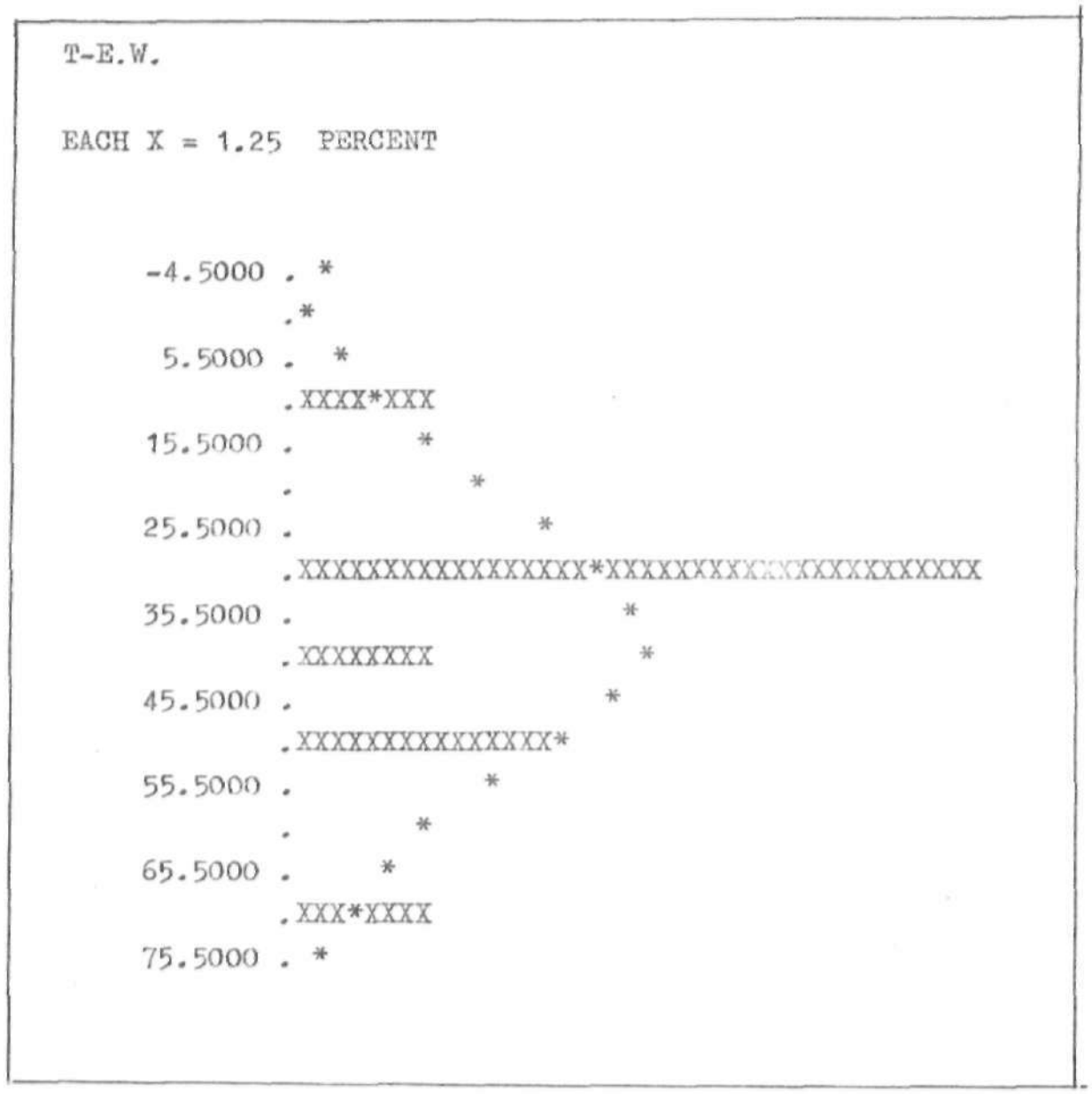

T-E.W.
EACH X = 1.25 PERCENT
-4.5000
5.5000
15.5000
25.5000
35.5000
45.5000
55.5000
65.5000
75.5000

FIG. 7.61

STATISTICAL ANALYSIS :CL.1969 T-I.W.

HISTOGRAM

OFFSET= 0.5

CELL WIDTH = 10

DATA

CONSTANT SUBTRACTED 90

50.0000
10.0000
10.0000
12.0000
23.0000
66.0000
60.0000
28.0000
28.0000
10.0000

N= 10
MEAN= 120.2000
STD.DEV= 21.4253
SKEWNESS= 0.5014
KURTOSIS= 1.5157
XMIN= 10.0000
XMAX= 66.0000
RANGE= 56.0000

C.VAR.= 17.8252

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-4.5000	0	0.00000
2	5.5000	4	40.00000
3	15.5000	0	0.00000
4	25.5000	3	30.00000
5	35.5000	0	0.00000
6	45.5000	1	10.00000
7	55.5000	1	10.00000
8	65.5000	1	10.00000

FIG. 7.62


T-I.W.
EACH X = 1.00 PERCENT
-4.5000
5.5000
15.5000
25.5000
35.5000
45.5000
55.5000
65.5000
75.5000

FIG. 7.63

STATISTICAL ANALYSIS CL. 1960 T-P&F.

HISTOGRAM
OFFSET= 0.5
CELL WIDTH = 9
DATA
CONSTANT SUBTRACTED 85

62.0000
15.0000
10.0000
22.0000
48.0000
65.0000
60.0000
30.0000
33.0000
15.0000

N= 10
MEAN= 121.0000
STD.DEV= 21.1765
SKEWNESS= 0.1941
KURTOSIS= 1.1947
XMIN= 10.0000
XMAX= 65.0000
RANGE= 55.0000

C.VAR.= 17.5012

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-4.0000	0	0.00000
2	5.0000	1	10.00000
3	14.0000	3	30.00000
4	23.0000	1	10.00000
5	32.0000	1	10.00000
6	41.0000	1	10.00000
7	50.0000	0	0.00000
8	59.0000	3	30.00000

FIG. 7.64

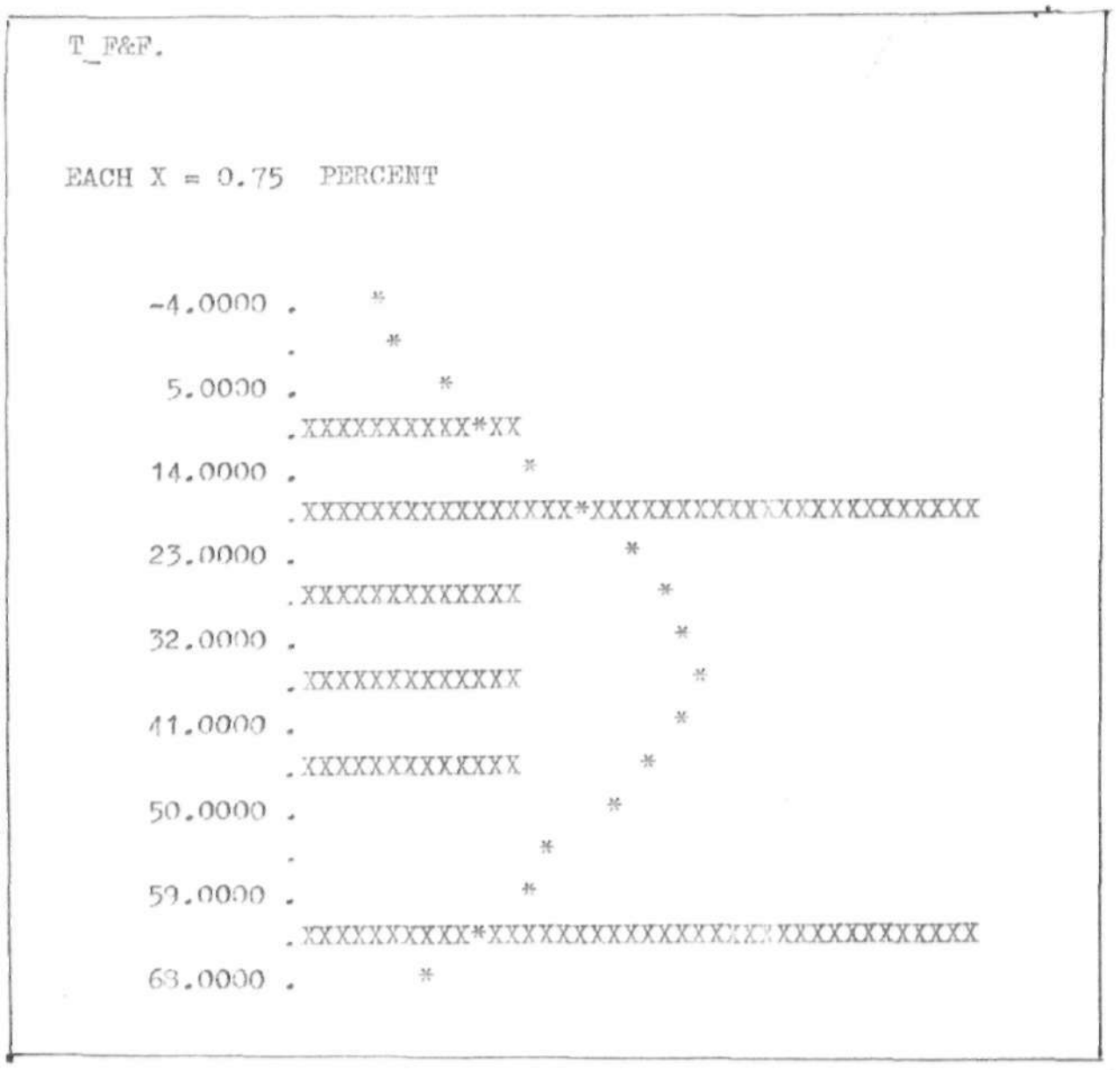

T_F&F.
EACH X = 0.75 PERCENT
-4.0000
5.0000
14.0000
23.0000
32.0000
41.0000
50.0000
59.0000
68.0000

FIG. 7.65

STATISTICAL ANALYSIS CL. 1969 T-SEC.

HISTOGRAM

OFFSET= 0.5

CELL WIDTH = 7

DATA

CONSTANT SUBTRACTED 35

45.0000
15.0000
20.0000
24.0000
33.0000
53.0000
49.0000
24.0000
10.0000
15.0000

N= 10

MEAN= 113.8000

STD. DEV= 15.3893

SKEWNESS= 0.3824

KURTOSIS= 1.3961

XMIN= 10.0000

XMAX= 53.0000

RANGE= 43.0000

C. VAR. = 13.5235

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-3.0000	0	0.00000
2	4.0000	1	10.00000
3	11.0000	2	20.00000
4	18.0000	3	30.00000
5	25.0000	0	0.00000
6	32.0000	1	10.00000
7	39.0000	1	10.00000
8	46.0000	1	10.00000
9	53.0000	1	10.00000

FIG. 7.66

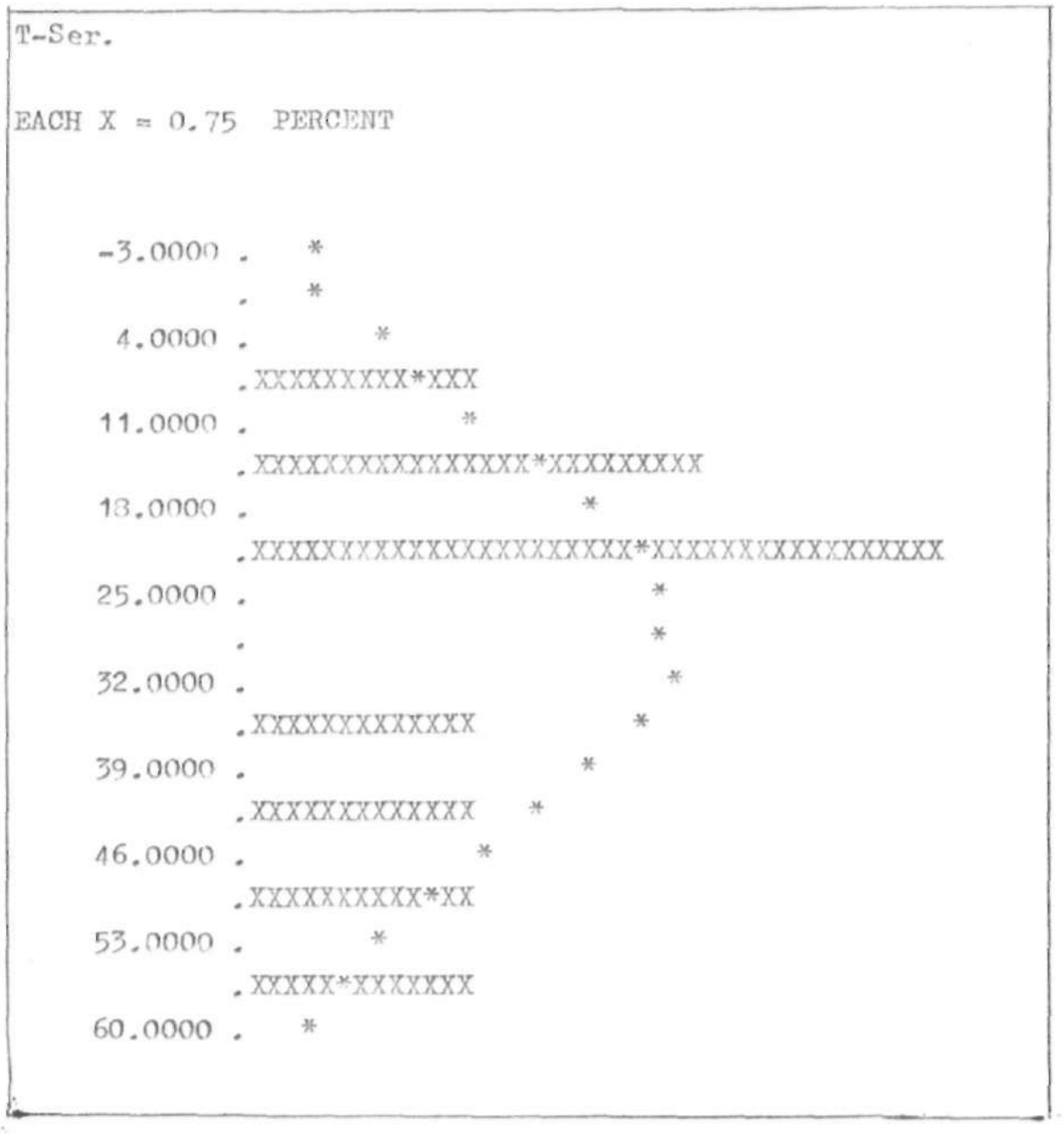

T-Ser.
EACH X = 0.75 PERCENT
-3.0000
4.0000
11.0000
18.0000
25.0000
32.0000
39.0000
46.0000
53.0000
60.0000

FIG. 7.67

LOCATION INDEX CLASSROOMS 1969

ELEMENTAL ANALYSIS

TOTAL COST LESS TWO ELEMENTS

	Location		T– S&R	T– S&E.W.	T– R & Ser	T– S.R. & S
1.	Kano	Cost	22.71	41.87	28.75	18.31
		Index	113	154	98	101
2.	Sabongida Ora		20.14	27.13	29.39	18.09
			100	100	100	100
3.	Sapele		25.40	27.93	34.04	24.08
			126	103	116	133
4.	Benin		39.28	33.69	40.91	35.85
			195	124	139	198
5.	Ilorin		21.80	31.08	32.39	18.59
			108	115	110	103
6.	Okene		31.89	26.10	40.29	28.89
			158	96	137	160
7.	Zaria		29.20	36.73	32.59	25.06
			145	135	111	139
8.	Makurdi		29.18	18.17	37.35	27.16
			145	67	127	150
9.	Ijebu Ode		22.37	27.96	24.30	14.92
			111	103	83	79
10.	Lagos		20.14	27.13	29.39	18.09
			100	100	100	100
	C.Var.		23.495	21.751	16.082	28.728

FIG. 7.68

```
                STATISTICAL ANALYSIS   CL. 1969 T-S&R.
HISTOGRAM
OFFSET=  0.5
CELL WIDTH =  16
DATA
CONSTANT SUBTRACTED 90
      23.0000
      10.0000
      36.0000
     105.0000
      18.0000
      68.0000
      55.0000
      55.0000
      21.0000
      10.0000

N=  10
MEAN=      130.1000
STD. DEV=       30.5667
SKEWNESS=        0.7855
KURTOSIS=        2.3535
XMIN=       10.0000
XMAX=      105.0000
RANGE=      95.0000

C. VAR. =      23.4948

CELL#    LOWER LIMIT    NO. OF OBS   %RELATIVE FREQ
   1       -7.5000          0          0.00000
   2        8.5000          5         50.00000
   3       24.5000          1         10.00000
   4       40.5000          2         20.00000
   5       56.5000          1         10.00000
   6       72.5000          0          0.00000
   7       88.5000          0          0.00000
   8      104.5000          1         10.00000
```

FIG. 7.69

```
T  S&R.

EACH X = 1.25  PERCENT


     -7.5000 .      *
             .       *
      8.5000 .           *
             .XXXXXXXXXXXX*XXXXXXXXXXXXXXXXXXXXXXXXXX
     24.5000 .                 *
             .XXXXXXXX           *
     40.5000 .                     *
             .XXXXXXXXXXXXXXX*
     56.5000 .                 *
             .XXXXXXXX     *
     72.5000 .           *
             .       *
     88.5000 .      *
             .   *
    104.5000 .   *
             .X*XXXXXX
    120.5000 . *
```

FIG. 7.70

STATISTICAL ANALYSIS CL. 1969 T-SAEM.

HISTOGRAM

OFFSET= 0.5

CELL WIDTH = 15

DATA

CONSTANT SUBTRACTED 60

94.0000
40.0000
43.0000
64.0000
55.0000
36.0000
75.0000
7.0000
43.0000
40.0000

N= 10

MEAN= 109.7000

STD.DEV= 23.8609

SKEWNESS= 0.1719

KURTOSIS= 2.3703

XMIN= 7.0000

XMAX= 94.0000

RANGE= 87.0000

C.VAR.= 21.7511

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-7.0000	1	10.00000
2	8.0000	0	0.00000
3	23.0000	1	10.00000
4	38.0000	4	40.00000
5	53.0000	2	20.00000
6	68.0000	1	10.00000
7	83.0000	1	10.00000

FIG. 7.71

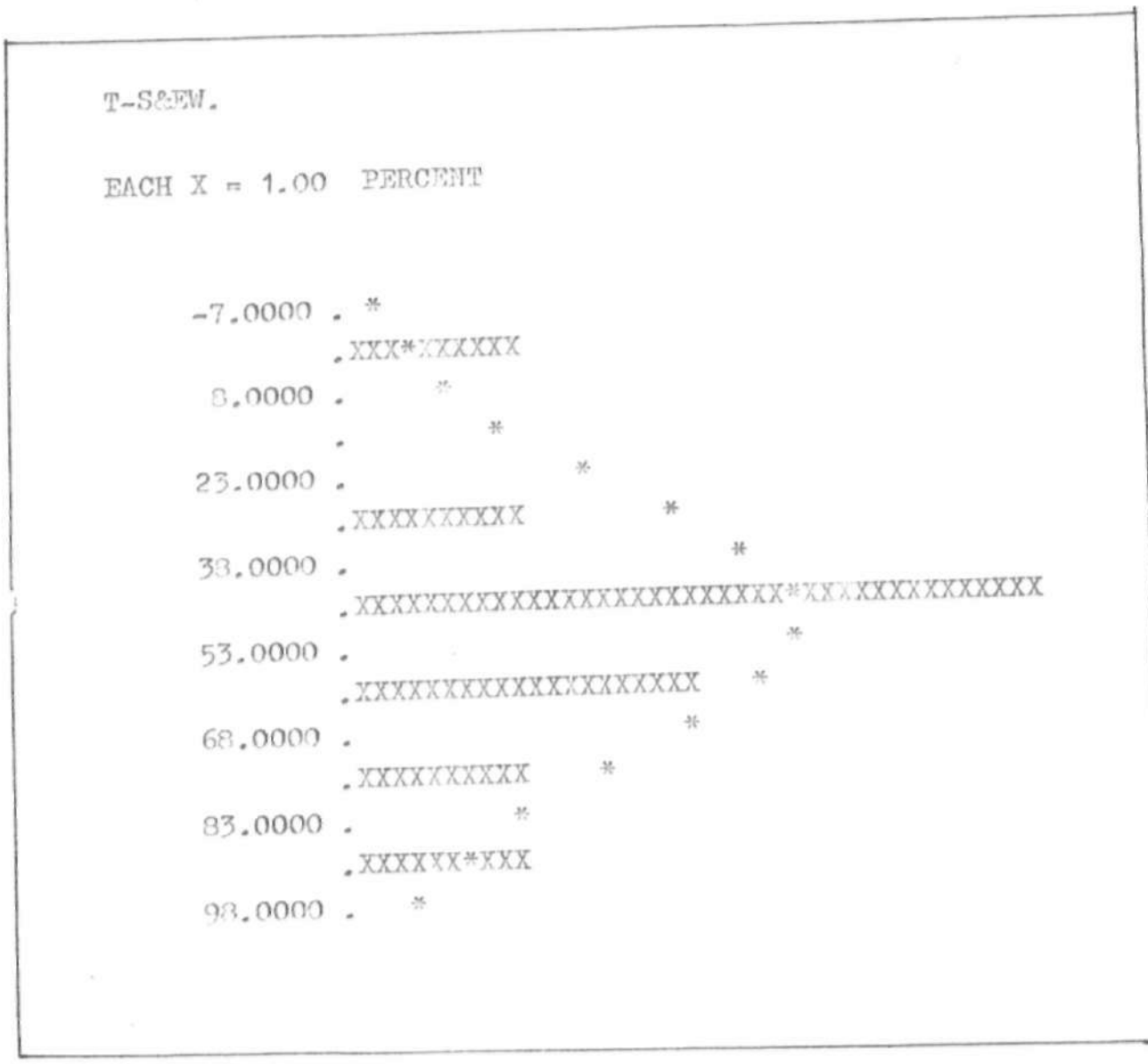

T-S&EW.
EACH X = 1.00 PERCENT
-7.0000
8.0000
23.0000
38.0000
53.0000
68.0000
83.0000
98.0000

FIG. 7.72

STATISTICAL ANALYSIS CL.1969 T-R&S.

HISTOGRAM

OFFSET= 0.5

CELL WIDTH = 10

DATA

CONSTANT SUBTRACTED :0

18.0000
20.0000
36.0000
50.0000
30.0000
57.0000
31.0000
47.0000
3.0000
20.0000

N= 10

MEAN= 112.1000

STD.DEV= 18.0274

SKEWNESS= 0.1241

KURTOSIS= 1.6636

XMIN= 3.0000

XMAX= 59.0000

RANGE= 56.0000

C.VAR.= 16.0816

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-4.5000	1	10.00000
2	5.5000	0	0.00000
3	15.5000	3	30.00000
4	25.5000	2	20.00000
5	35.5000	1	10.00000
6	45.5000	1	10.00000
7	55.5000	2	20.00000

FIG. 7.73

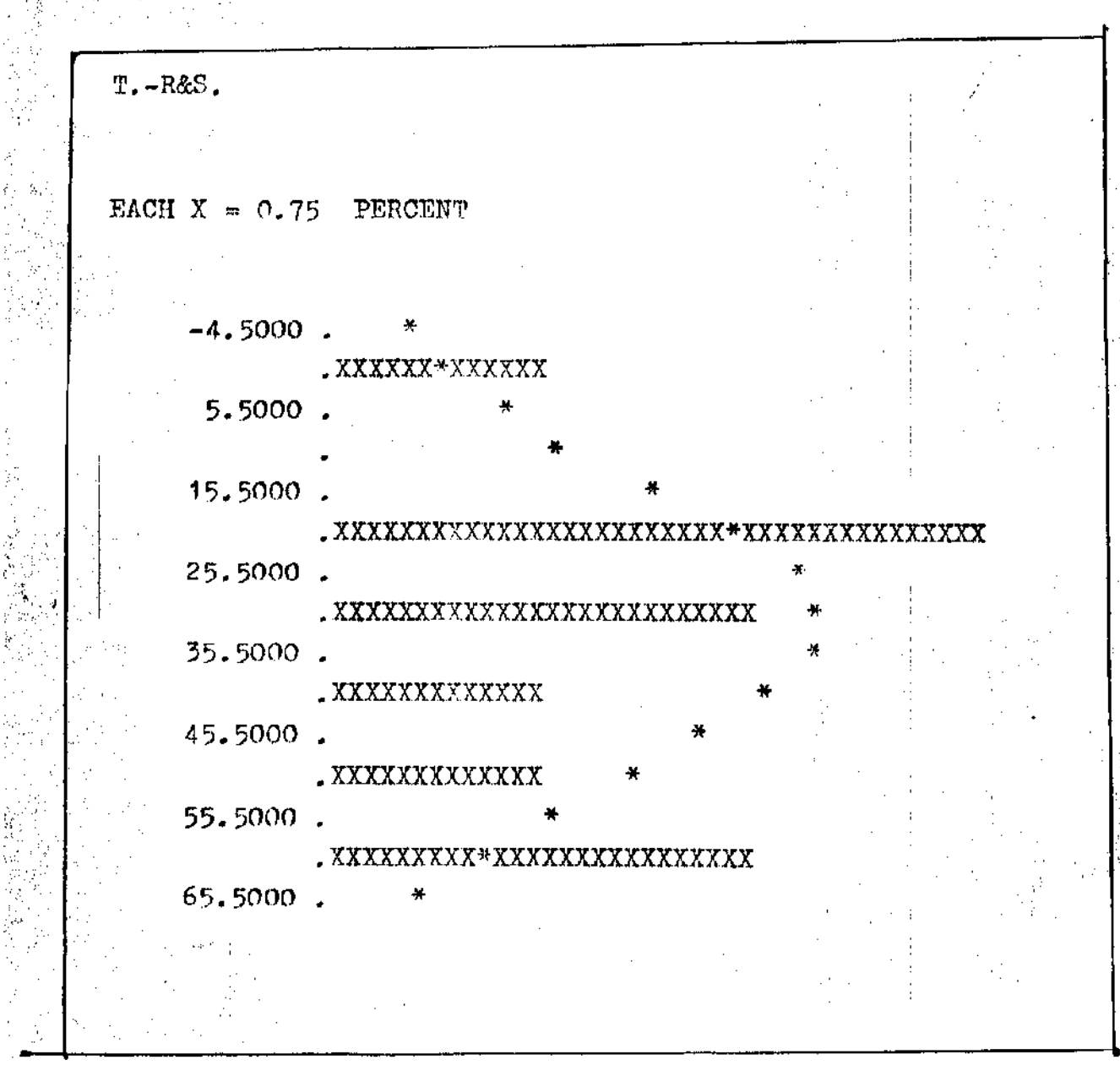

T.-R&S.
EACH X = 0.75 PERCENT
-4.5000
5.5000
15.5000
25.5000
35.5000
45.5000
55.5000
65.5000

FIG. 7.74

STATISTICAL ANALYSIS CL.1969 T-SHS.

HISTOGRAM

OFFSET= 0.5

CELL WIDTH = 20

DATA

CONSTANT SUBTRACTED 70

31.0000
30.0000
63.0000
126.0000
33.0000
90.0000
69.0000
80.0000
9.0000
30.0000

N= 10

MEAN= 126.3000

STD.DEV= 36.2030

SKEWNESS= 0.4265

KURTOSIS= 2.0039

XMIN= 9.0000

XMAX= 128.0000

RANGE= 119.0000

C.VAR.= 28.7276

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-9.5000	1	10.00000
2	10.5000	2	20.00000
3	30.5000	2	20.00000
4	50.5000	2	20.00000
5	70.5000	2	20.00000
6	90.5000	0	0.00000
7	110.5000	1	10.00000

Fig. 7.75

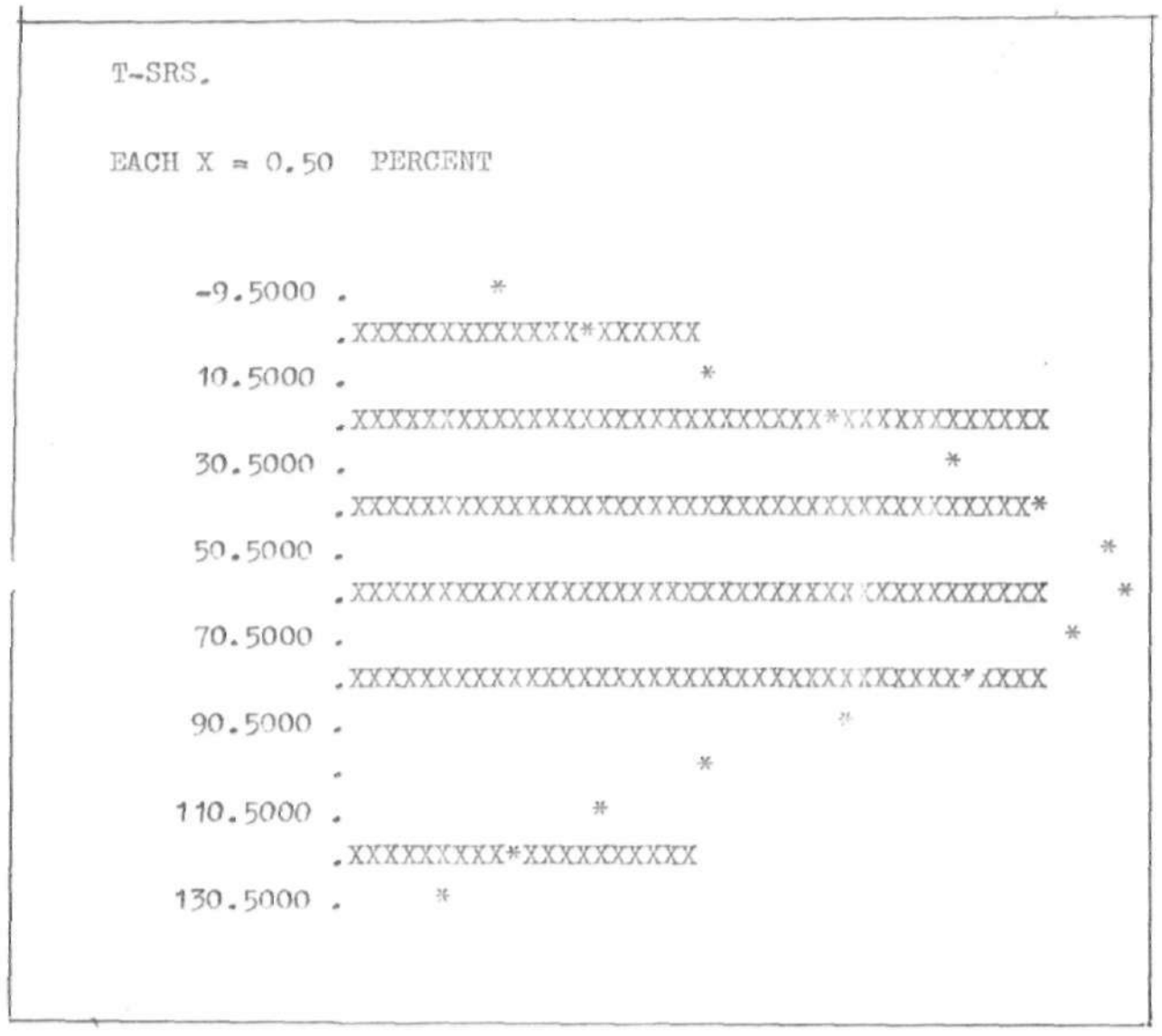

T-SRS.
EACH X = 0.50 PERCENT
-9.5000
10.5000
30.5000
50.5000
70.5000
90.5000
110.5000
130.5000

FIG. 7.76

LOCATION INDEX CLASSROOMS 1969

ELEMENTAL ANALYSIS

TOTAL COST LESS THREE ELEMENTS

	LOCATION		T - S & EW & I.W	T.-R.E.W.& F & F
1.	Kano	Cost	34.66	23.67
		Index	171	117
2.	Sabongida Ora		20.24	20.24
			100	100
3.	Sapele		19.78	19.43
			98	96
4.	Benin		22.49	26.26
			111	130
5.	Ilorin		21.99	26.10
			109	129
6.	Okene		23.40	16.90
			116	83
7.	Zaria		32.36	16.04
			160	79
8.	Makurdi		14.29	16.09
			71	79
9.	Ijebu-Ode		24.68	20.11
			122	99
10.	Lagos		20.24	20.24
			100	100
	C.Var.		25.636	18.643

FIG. 7.77

STATISTICAL ANALYSIS T-S&EW&IW.

HISTOGRAM

OFFSET= 0.5

CELL WIDTH = 17

DATA

CONSTANT SUBTRACTED 65

106.0000
35.0000
33.0000
46.0000
44.0000
51.0000
95.0000
6.0000
57.0000
35.0000

N= 10

MEAN= 115.3000

STD. DEV= 29.6865

SKEWNESS= 0.5763

KURTOSIS= 2.2350

XMIN= 6.0000

XMAX= 106.0000

RANGE= 100.0000

C.VAR.= 25.6360

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-8.0000	1	10.00000
2	9.0000	0	0.00000
3	26.0000	3	30.00000
4	43.0000	4	40.00000
5	60.0000	0	0.00000
6	77.0000	0	0.00000
7	94.0000	2	20.00000

FIG. 7.78

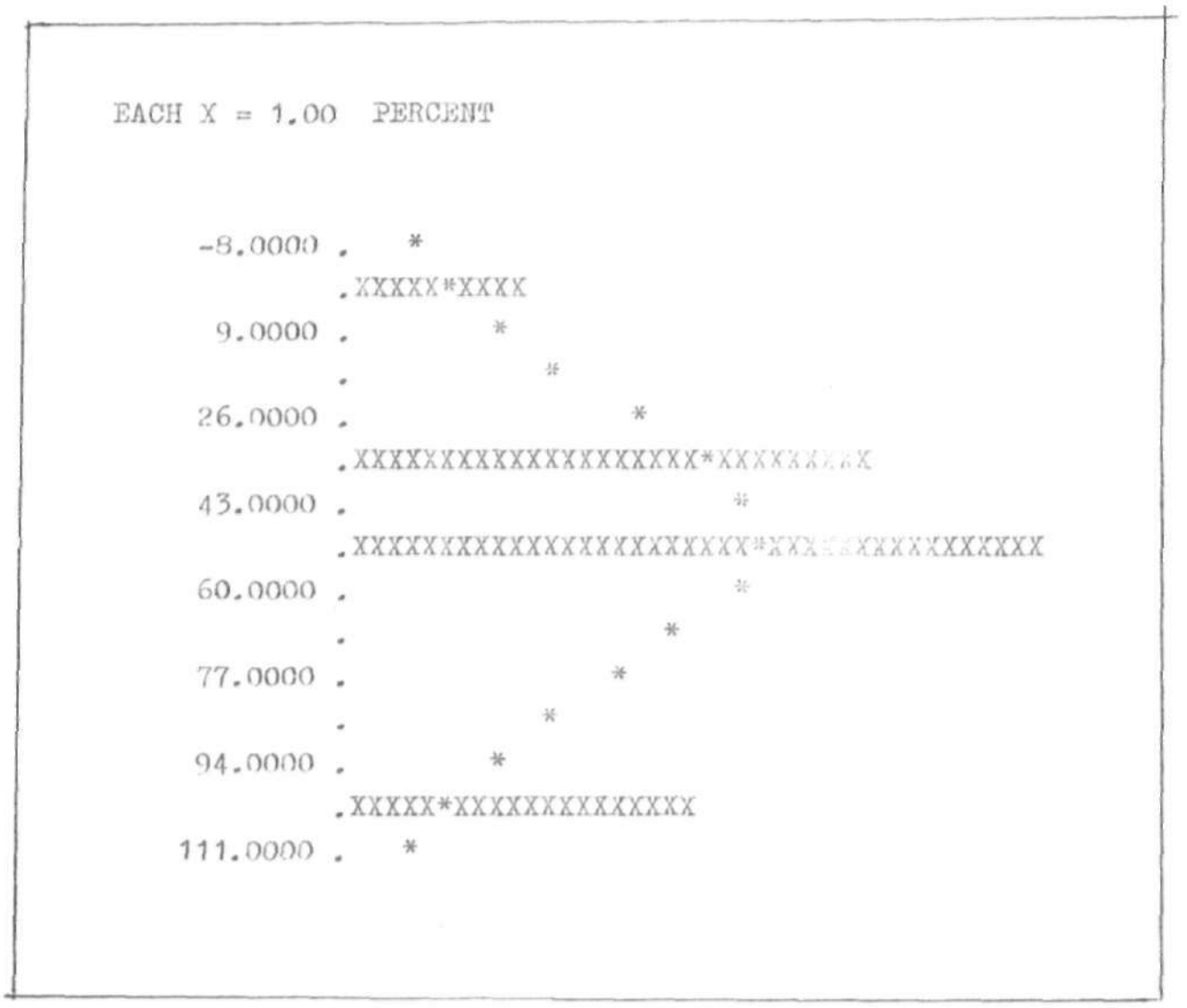

EACH X = 1.00 PERCENT
-8.0000
9.0000
26.0000
43.0000
60.0000
77.0000
94.0000
111.0000

FIG. 7.79

STATISTICAL ANALYSIS T-R&EW&FF.

HISTOGRAM

OFFSET= 0.5

CELL WIDTH = 8

DATA

CONSTANT SUBTRACTED 70

47.0000
30.0000
26.0000
60.0000
59.0000
13.0000
9.0000
9.0000
29.0000
30.0000

N= 10

MEAN= 101.2000

STD.DEV= 18.8668

SKEWNESS= 0.3164

KURTOSIS= 1.5341

XMIN= 9.0000

XMAX= 60.0000

RANGE= 51.0000

C.VAR.= 18.6431

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-3.5000	0	0.00000
2	4.5000	2	20.00000
3	12.5000	1	10.00000
4	20.5000	1	10.00000
5	28.5000	3	30.00000
6	36.5000	0	0.00000
7	44.5000	1	10.00000
8	52.5000	2	20.00000

FIG. 7.80

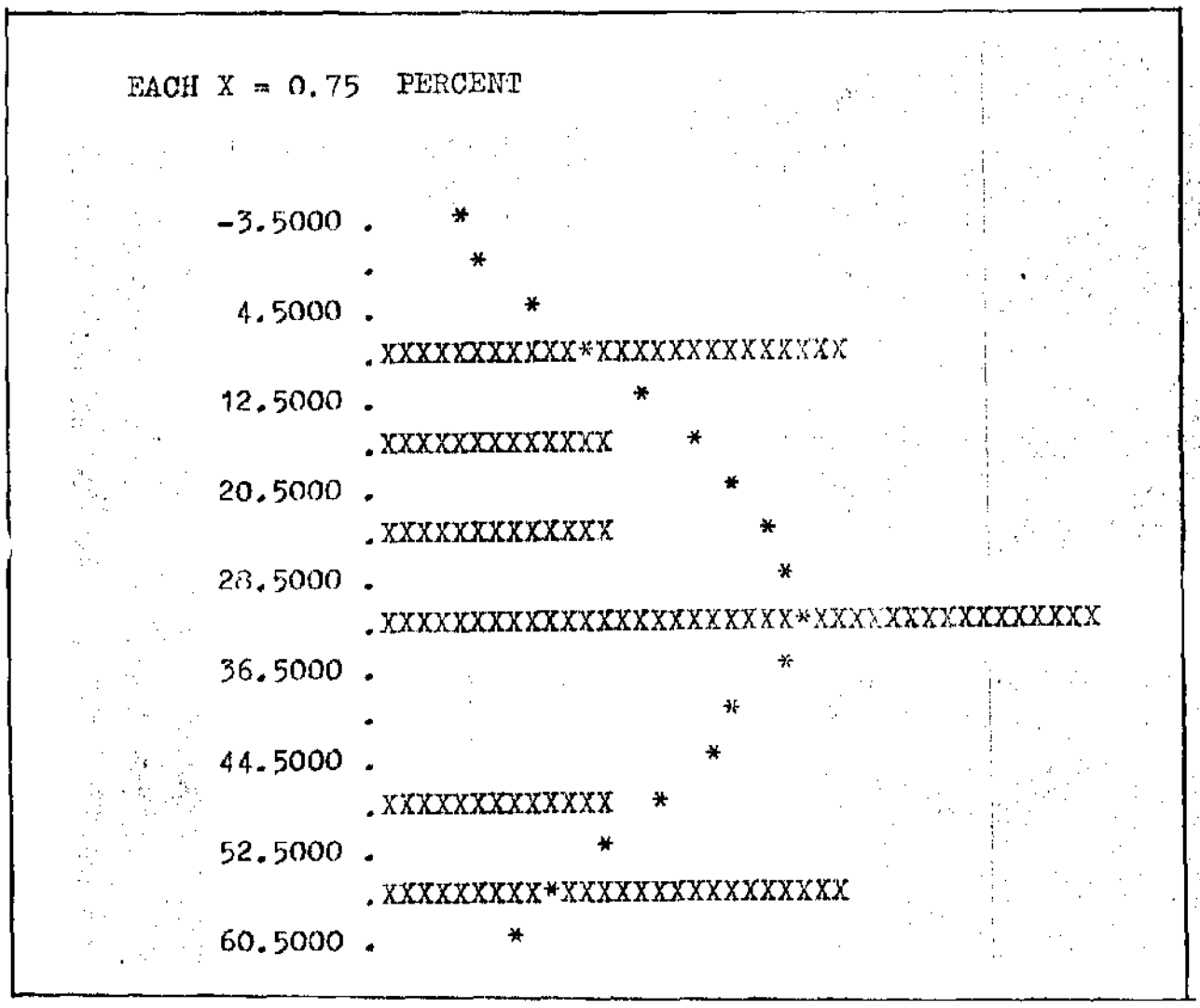

EACH X = 0.75 PERCENT
-3.5000
4.5000
12.5000
20.5000
28.5000
36.5000
44.5000
52.5000
60.5000

FIG. 7.81

LOCATION INDEX CLASSROOMS 1969

ELEMENTAL ANALYSIS

TOTAL COST LESS FOUR ELEMENTS

LOCATION		T-S.R.W.I.W.	T.-S.E.W.I.W.F&F	T-R.I.W.F&F Ser
1. Kano	Cost	8.07	32.61	19.49
	Index	112	216	112
2. Sabongida Ora		7.22	15.07	17.33
		100	100	100
3. Sapele		9.47	11.63	17.74
		131	7	102
4. Benin		17.32	15.17	22.39
		240	101	129
5. Ilorin		4.22	20.98	22.29
		58	139	129
6. Okene		5.35	20.95	35.14
		74	139	2.03
7. Zaria		8.19	28.31	24.17
		113	188	139
8. Makurdi		5.33	10.98	30.16
		74	73	174
9. Ijebu Ode		8.71	23.42	19.76
		121	155	114
10. Lagos		7.22	15.07	17.33
		100	100	100
C.Var.		44.935	38.811	26.248

FIG. 7.82

STATISTICAL ANALYSIS T-SQUARED TEST

HISTOGRAM

OFFSET= 0.5

CELL WIDTH = 30

DATA

CONSTANT SUBTRACTED 50

62.0000
50.0000
81.0000
190.0000
8.0000
24.0000
63.0000
24.0000
71.0000
50.0000

N= 10

MEAN= 112.3000

STD.DEV= 50.4624

SKEWNESS= 1.4112

KURTOSIS= 4.3041

XMIN= 8.0000

XMAX= 190.0000

RANGE= 182.0000

C.VAR.= 44.9354

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-14.5000	1	10.00000
2	15.5000	2	20.00000
3	45.5000	5	50.00000
4	75.5000	1	10.00000
5	105.5000	0	0.00000
6	135.5000	0	0.00000
7	165.5000	1	10.00000

FIG. 7.83

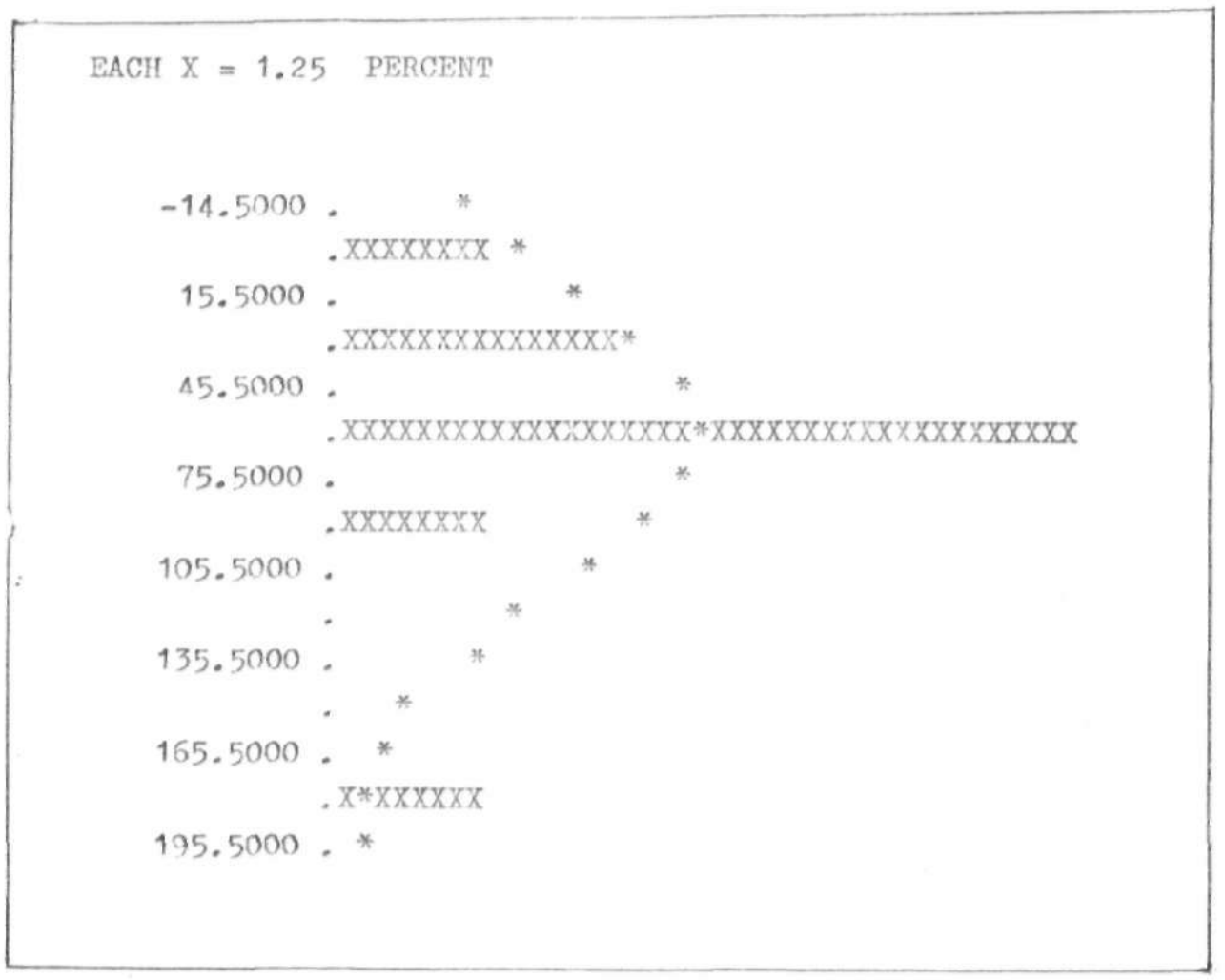

EACH X = 1.25 PERCENT
-14.5000
15.5000
45.5000
75.5000
105.5000
135.5000
165.5000
195.5000

FIG. 7.84

STATISTICAL ANALYSIS . CL.1969 T-S.EW.IW.F&F.
HISTOGRAM
OFFSET= 0.5
CELL WIDTH = 24
DATA
CONSTANT SUBTRACTED 70

146.0000
30.0000
7.0000
31.0000
69.0000
69.0000
118.0000
3.0000
85.0000
30.0000

N= 10
MEAN= 128.8000
STD.DEV= 47.4126
SKEWNESS= 0.4772
KURTOSIS= 1.7704
XMIN= 3.0000
XMAX= 146.0000
RANGE= 143.0000

C.VAR.= 36.8110

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-11.5000	2	20.00000
2	12.5000	3	30.00000
3	36.5000	0	0.00000
4	60.5000	2	20.00000
5	84.5000	1	10.00000
6	108.5000	1	10.00000
7	132.5000	1	10.00000

FIG. 7.85

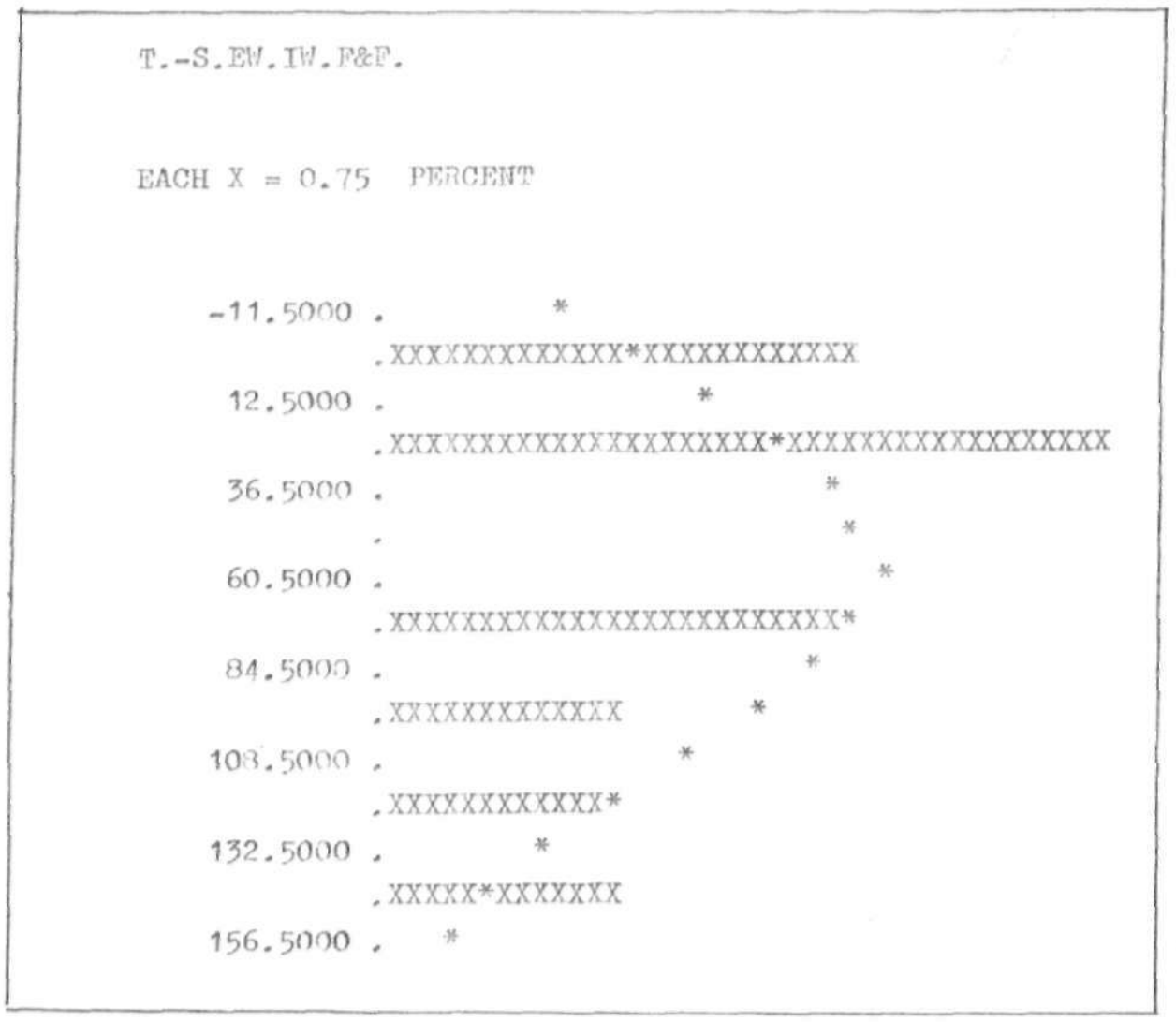

T.-S.EW.IW.F&F.
EACH X = 0.75 PERCENT
-11.5000
12.5000
36.5000
60.5000
84.5000
108.5000
132.5000
156.5000

FIG. 7.86

T-R&IW&FF&SER.

STATISTICAL ANALYSIS

HISTOGRAM
OFFSET= 0.5
CELL WIDTH = 17
DATA
CONSTANT SUBTRACTED 90

22.0000
10.0000
12.0000
39.0000
39.0000
113.0000
49.0000
84.0000
24.0000
10.0000

N= 10
MEAN= 130.2000
STD. DEV= 34.1754
SKEWNESS= 0.9589
KURTOSIS= 2.5107
XMIN= 10.0000
XMAX= 113.0000
RANGE= 103.0000

C.VAR.= 26.2434

CELL#	LOWER LIMIT	NO. OF OBS	%RELATIVE FREQ
1	-8.0000	0	0.00000
2	9.0000	5	50.00000
3	26.0000	2	20.00000
4	43.0000	1	10.00000
5	60.0000	0	0.00000
6	77.0000	1	10.00000
7	94.0000	0	0.00000
8	111.0000	1	10.00000

FIG. 7.87

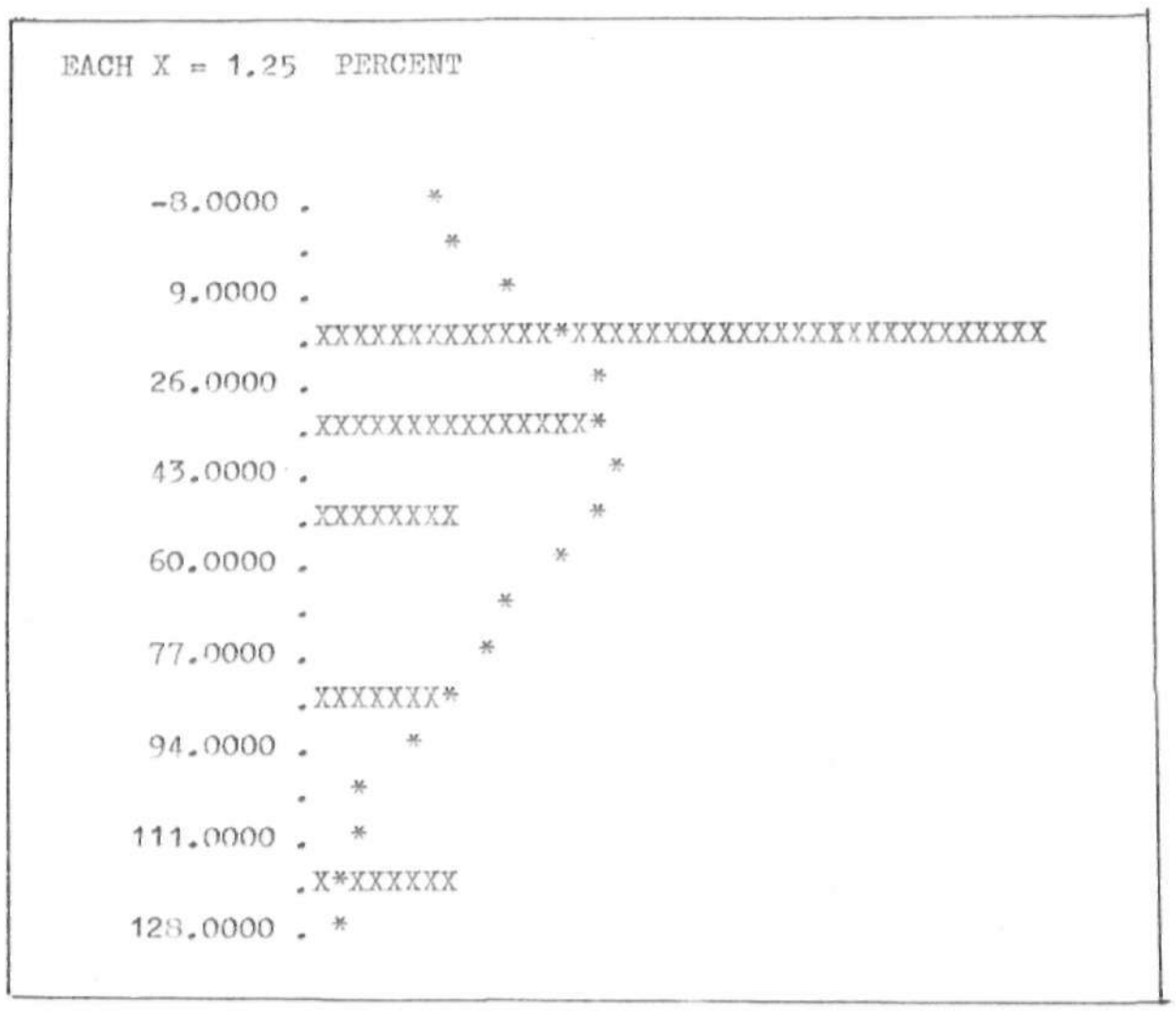

EACH X = 1.25 PERCENT
-8.0000
9.0000
26.0000
43.0000
60.0000
77.0000
94.0000
111.0000
128.0000

FIG. 7.88

SUMMARY ELEMENTAL ANALYSIS

ITEM	* COEFFICIENTS OF VARIATION					
1. Total Cost of building	13.18	21.75	23.59	15.21	9.15	14.61
2. Total cost less one element	17.46	13.03	15.69	17.83	17.50	13.52
3. Total cost less two elements	23.50	21.75	16.08			
4. Total cost less threeelements	28.73	25.64	18.64			
5. Total cost less four elements	44.94	26.25	38.81			
6. Individual elements of building	23.52	43.42	55.61	43.43	61.50	53.47

FIG. 7.89

CHAPTER 8

Proposed Building Cost Indices in Nigeria

8.01 Method of Preparation

The Unit Rate and the Historical Cost methods have been examined in detail. The Historical cost method has the advantage that it reflects market conditions and productivity but the groups of data are so widely dispersed around the mean that from the statistical point of view the data is not accurate enough to be used for pre-design estimates.

The Unit Rate method provides the required degree of accuracy but does not directly reflect changes in market conditions and productivity. Market conditions are continually changing from location to location and from time to time according to the volume of new construction work being tendered. This factor can best be assessed by the quantity surveyor on the spot at any given time. Changes in productivity are more difficult to deal with. There is no evidence that contractors pass on the benefits of seasonal changes in productivity to prospective building owners. It is however safe to assume that national increases in productivity due to improvements in technology and the training of manpower will in due course be reflected in building costs. This variable can be measured by continually reviewing the labour outputs by consultation with contractors and observation on construction sites. The Unit Rate method also has the advantage that it can be processed and published very quickly. Sweett[11] explains that his practice prepare their own indices to overcome the time lag which arises between the occurrence of price movements and the inclusion of their consequences in published building cost indices.

On balance the evidence weighs heavily in favour of the use of the Unit Rate method for the preparation of building cost indices in Nigeria.

8.02 Organisation

A large organisation would not be necessary for the preparation of building cost indices. It is suggested that a Building Cost Research Section be incorporated in the proposed Construction Material Research Centre to be attached to the Department of Civil Engineering, Ahmadu Bello University, Zaria, Nigeria.

The/

The staff required would consist of two or three research fellows under the control of the Department of Surveying, supported by a suitable number of technicians and clerical staff. It is possible that the research fellows will be found as a result of the recruitment of graduate assistants who would be researching for higher degrees. The section would require a generous annual allowance for travelling expenses. Sufficient computer facilities are already available within the University. Informal inquiries are being made to see if the Federal Ministry of Housing, Urban Development and Environment would be willing to finance the preparation of the indices.

8.03 Source and Collection of Data

It is suggested that cost data be collected and processed for each state capital and published in the form of location and time scale indices.

Each location should be visited initially half yearly and later, when the organisation is well established, the visits should be quarterly. Current material and labour costs should be collected during each visit. Construction sites and contractors offices should be visited to ascertain labour and plant outputs. Any variation in outputs due to location or climatic conditions should be noted. In some instances this information will be available from the contractors. In others it will have to be obtained by doing case studies on construction sites.

8.04 Processing

The computer programme prepared for this research contains analysis for about forty of the main items of construction work. This would have to be expanded to provide Schedules of Rates which are sufficiently comprehensive to price bills of quantities for fairly complex buildings of varying structural forms and specifications. A considerable amount of the analysis required is already available in the Department of Surveying.

Typical types of buildings constructed in Nigeria should be identified and cost indices prepared for each type. It is suggested that the classes should be:-

(i) Load bearing blockwork up to three stories high.
(ii) Reinforced concrete multi-storey construction.
(iii) Steel framed multi-storey construction.
(iv) Light framed steel or concrete construction.

These classes could be further sub-divided according to building function.

Unpriced/

Unpriced bills of quantities for typical buildings in each section should be obtained. These should be coded and stored in the computer. Each bill would be priced for each location each time the cost data was collected. The priced bills would be analysed into costs per square metre of floor area for each building and then converted to location and time scale indices ready for publication.

CHAPTER 9

FUTURE RESEARCH WORK

9.01 General

The aim of this research was to provide for the improvement of the accuracy of pre-design estimates by developing an accurate method of measuring the effect on building costs of the variables time and location. However, variations in building cost are due to many factors. It is now necessary to devise methods of quantifying all the variables and bringing them all together to produce a pre-design estimate.

It is possible to analyse a completed project and allocate values to each of the variables so that the total value of the variables equals the project cost. However, to use that information for a pre-design estimate, it will be necessary to substitute new values for some of the variables. The problem is how to measure the effect of a change in the value of one or more variables on the values of the remaining variables. This can be done by preparing mathematical models for each type of building using a technique called multiple regression analysis. The following sections are a review of some recent papers describing some of the uses of this technique in connection with construction work.

9.02 Estimating for Civil Engineering Works

Hughes[21] in a recent paper discusses the problems of pre-design estimates for civil engineering works. The following is a synopsis of his paper. He advises that in considering technique to be employed quantity surveyors should reflect on the suitability of methods devised for use in the context of building before using them in circumstances for which they were not introduced. Engineers claim some experience in the field of estimating and are certainly more knowledgeable than their architect counterpart as to how a particular job may have to be done and the plan or risks that are likely to be involved. Also by their training they are more concerned with the economics of design. That they express their problem in tonnes or metres is as valid as the quantity surveyors use of the Naira as a unit. In the case of buildings there are usually several options open in solving a given problem. In engineering problems tend to be more unique and their solution dictated by engineering considerations. For these reasons cost planning and cost control as applied in building are in general not applicable to civil engineering. The validity of any technique must be judged in terms of its performance in practice.

At/

At feasibility stage it is a simple technique to correlate units of requirement with final total cost. A simple mathematical model for a road would be:

length x breadth x cost per square metre = estimate cost.

In connection with dual three lane rural motorways it was found that costs varied between ₦1m and ₦3m. per mile. Clearly this represented too large a variation to be of any practical use. Attention was therefore turned towards identifying those parameters which were measurable at feasibility stage, such as rise and fall of ground, geology, climate, crossings of other roads, rivers and railways, etc. Altogether, upwards of 17 were selected. By the use of multiple regression analysis it was possible to produce coefficients for 11 factors, the remainder being discarded as statistically non-significant. The model derived took the following form:

$$276 + \frac{116\ X_1}{} + \frac{144\ X_2}{} + \frac{108\ X_3}{} + \frac{719\ X_4}{} + 382\ X_6 + \frac{155\ X_9}{} + \frac{805\ X_{10}}{} - 0.72\ X_{12} + 10\ X_{14} + 65\ X_{15} - 71\ X_{17} = 1000$$

where

X_1 & X_2	=	rise and fall of ground
X_3 & X_4	=	road crossings
X_6	=	small waterways
X_9	=	rail crossings
X_{10}	=	interchanges
X_{12}	=	height above sea level
X_{14}	=	population factor
X_{15}	=	rainfall
X_{17}	=	geological factor

the method of measuring these parameters being defined. The model gave results with a standard error of ± ₦98,000 per Km. and a coefficient of variation of about 9% when applied to cases (32) from which the data had been derived. The coefficient of variation being obtained with 'conventional' methods of estimating for corresponding schemes was around 25 - 30%. Further development work is continuing. The aim is not so much a coefficient of variation of say 10% as applied to cases from which data has been derived but one of perhaps 20% or less when applied to new cases compared with 34% being currently obtained.

9.03/

9.03 Regression Analysis as an Estimating Tool

Estimating based on statistical methods[22] has the appeal of condensing historical records into a usable form. Regression analysis as a cost modelling tool is a technique which enables the cost of a project to be expressed in a very few items. For example a cost model developed by regression analysis for residential apartment blocks may be:

Cost (at models base data)

= 36001.75 + (169.84 x area of single units)
+ (137.38 x area of double units)
+ (2553.8 x number of storeys)
+ (3049.53 x number of lifts x number of storeys)
+ (139.85 x Total access area)
+ (395.88 x Common Room areas)
+ (13335.43 x number of garages)

and if the model variables had the following values in one particular case

Area of single units	=	1044
Area of double units	=	281
No. of storeys	=	3
No. of lifts	=	1
Total access area	=	550
Common Room Areas	=	87
No. of garages	=	1

the estimator could quickly show that the cost at models base date was £393,423.

Obviously it is much quicker to calculate likely costs in this way rather than by approximate design, approximate quantities and approximate rates. In several cases it has been found that these cost prediction models are significantly more accurate than designers early estimates. Thus in appropriate cases cost models based on regression analysis can provide a substantial improvement on existing methods of estimating for cost planning purposes.

Regression/

Regression Analysis is a technique that will find an expression or formula or mathematical model which best describes the data collected. The process is only practicable if computer facilities are available. There are several computer packages which permit the user to present his data in a prescribed manner to the computer package and all the calculations are done automatically. At Loughborough University the computer package used is "Nimbus"[23] supported with programs for storing data and selecting different combinations of variables. Using this programme regression analysis and cost model building is reduced to a routine exercise given access to data.

9.04 Pre-design Cost - Estimation Function for Buildings

Kouskoulas and Koehn [24] recognising the need for pre-design cost estimation techniques attempt to solve the problem by deriving a single cost-estimation function that applies to several classes of buildings and defines cost in terms of several other measurable variables. The end result is a pre-design multilinear cost-estimation function.

The cost of a building is a function of many variables. The first and basic problem is the selection of a set of independent variables that may describe a project and define its cost. Such variables must be measurable for each new building project. The second problem is the determination of the cost function in terms of the selected variables in closed mathematical form. Whatever technique one may choose for the construction of the cost function, its immediate use dictates that a criterion for the selection of the variables is the availability of data on such variables from building projects completed in the past. These data are not only required for the construction of cost functions, but also for solving the third problem i.e. testing the realiability of the derived function.

Guided by these principles and after extensive search regarding the availability of data, one may define the cost function by the relation

$$C = f(V_1,\ldots,V_6) \quad - - - - - - - - - - - - - - - (1)$$

in which C = some cost measure characteristic of buildings; and V_k = six independent variables, which are in squence specifying building locality, price index, building type, building height, building quality and building technology.

Each/

Each of the variables are examined individually and their measurement and the derivation of the function are described. The mathematical tools employed during the development of the methodology included the use of the ideas of regression, correlation and probability analysis. The regression analysis was performed by using one of the many available statistical analysis computer packages.

The methodology developed requires that a complete record of the sample building data is maintained with a concise definition of the variables and their values used in deriving the cost function. In estimating the cost of a new building project, it is instructive that the new project is compared with similar projects in the data for consistency in the assignment of the variables. It is also instructive that data are updated and the cost function is rederived periodically.

CHAPTER 10

Summary, Conclusions and Recommendations

10.1 Summary

The object of the research was to investigate existing construction cost patterns in Nigeria and from the results obtained to propose a system for defining these patterns so that they could be used to improve the accuracy of pre-tender estimates.

The research was conducted by using two methods:-

(a) Synthesis: the building up of building cost data using actual costs of labour and materials.

(b) Analysis: Analysing the costs of projects for which cost data was available.

The results were tabulated as costs per square metre of floor area and as location and time scale indices. Proposals were made for the preparation of building cost indices in Nigeria.

10.2 Conclusions

The predominant factor which has emerged from the results is that, in Nigeria, cost variations due to location are as important, as those due to time. Most published work[14.20] has tended to ignore the location factor.

Avery[24], however, lists the factors which will influence cost in a particular location as:

1. Distance from source of material supply.
2. Availability and cost of labour.
3. Productivity.
4. Cost of plant.
5. Cost of water.
6. Cost of power.
7. Weather conditions and hours of daylight.
8. Local differences in market conditions.
9. Topographical conditions.
10. Geological conditions and Biological activity.
11. Availability of materials, skills and facilities.
12. Localised customs and regulations.

In/

In a given location it is possible to investigate each of these factors. It is suggested that the introduction to the published indices should contain any data available on any of these factors in respect of each location. The data should be reviewed and updated at regular intervals.

Any activities which can identify and increase understanding of location cost are desirable.

10.03 Recommendation

It is recommended that a Building cost Research Section be incorporated in the proposed Construction Material Research Centre to be attached to the Department of Civil Engineering, Ahmadu Bello University, Zaria, Nigeria.

That the Research Section prepare building cost indices based on an expanded Unit Rate method as described in this thesis.

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22./

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APPENDIX No. 1

Building Cost Indices in Britain

1.01 General

The purpose of this appendix is to describe in some detail the labour and material method of producing building cost indices.

These indices are prepared by the Building Cost Information Services (B.C.I.S) which is operated by the Royal Institute of Chartered Surveyors in London. It provides a cost information service to practising members of the quantity surveying profession. Schools of Surveying, Colleges and Universities can also be members. The members pay a subscription and also provide the cost data necessary for the preparation of the indices. A quarterly supplement is issued containing tables of costs. In addition to this data an index is provided showing changes in the following factors affecting cost.

(a) Labour costs
(b) Productivity
(c) Material prices
(d) Fluctuations risk
(e) Market conditions

1.02 Compilation

The indices measure the effects on tender levels arising from changes in:

(a) Labour costs: the indices allow for changes in basic hourly wages rates, national insurance payments, holidays with pay, number of hours worked per week etc. and are adjusted for changes in productivity.

(b) Material Prices: From a study of actual Bills of Quantities a system of weightings was devised to allow for changes in material costs, according to the different quantities of materials used in different types of construction. Consequently, a steep rise in brick prices bears more heavily on the index for Brick construction than on the index for steel framed Buildings. The labour index and the material index are weighted together.

(c)/

(c) Fluctuations Risk: The indices also reflect changes in the assessed value of fluctuations' risk on firm price tenders.

(d) Market Conditions: A further adjustment is made to the indices to reflect the effect on tender levels of market conditions.

1.03 Data in Graphic Form:

The first set of graphs is shown in Fig. 101. These graphs include the following:-

Graph 1: *Plots the BCIS Index Class C. Brickwork construction.*

Graph 2: Shows the influence which labour and material increases have on the index.

Graph 3: Is the allowances for the fluctuations' risk in firms price tenders.

Graph 4: Indicates the changes in the "Market Conditions Factor".

It can be seen from this diagram that the Labour and Material index rose by 15% from the 1st Quarter of 1958 to the 2nd quarter of 1964. Market conditions over the same period rose from - 3 points to + 25 points.

Fig. 1.02

Graph 5: Shows the changes in the basic hourly wage rates.

Graph 6: is the "All-in" Hourly Wage Rate. It consists of the basic hourly wage rates, holidays with pay schemes, national insurance, graduated pension schemes constributions, overtime and supervision. The "all-in" hourly wage rates are used in the compilation of the B.C.I.S. index. It can be seen from the graph that future wage increases are included in the firm price index as soon as the announcement of the increase is made.

Fig. 1.03: Shows the crude labour and material index.

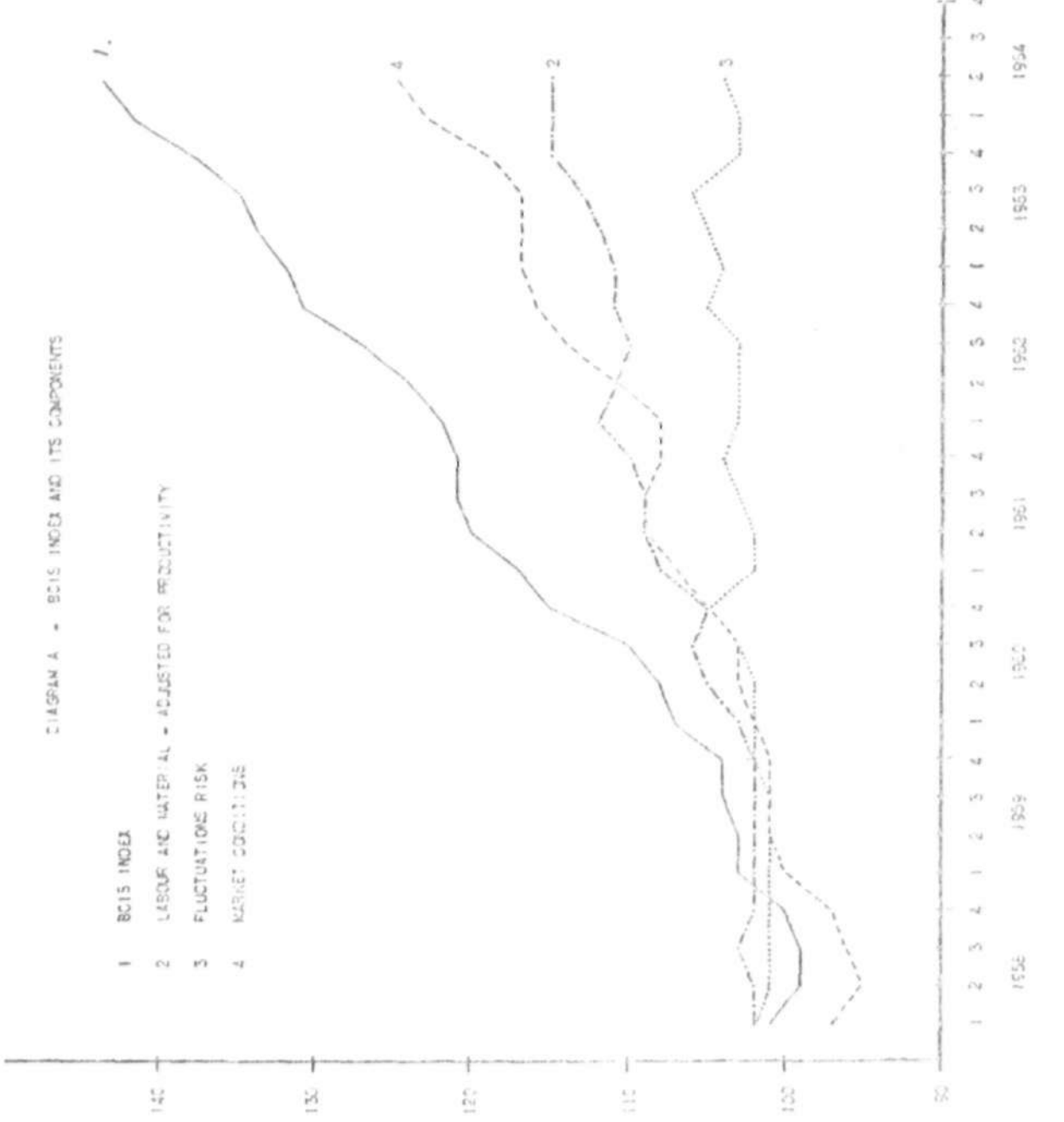

DIAGRAM A - BCIS INDEX AND ITS COMPONENTS
ADJUSTED FOR PRODUCTIVITY
1 BCIS INDEX
2 LABOUR AND MATERIALS
3 FLUCTUATIONS RISK
4 MARKET CONDITIONS
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
140
130
120
110
100
90

FIG. 101

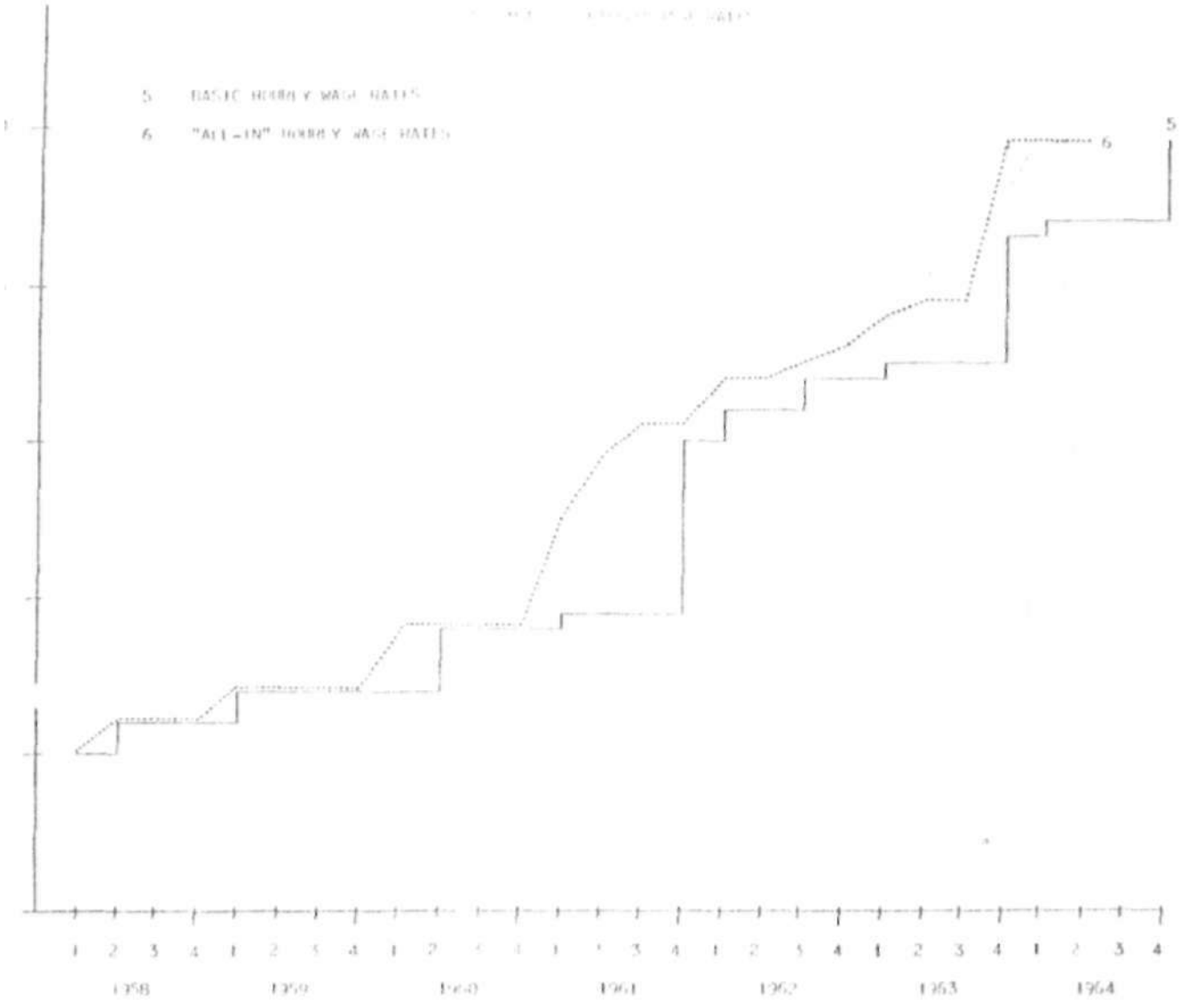

5 BASIC HOBBY WAGE RATES
6 "ALL-IN" HOBBY WAGE RATES
5
6
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
1958
1959
1960
1961
1962
1963
1964

FIG. 1.02

Section 2 - Crude Labour and Material Index

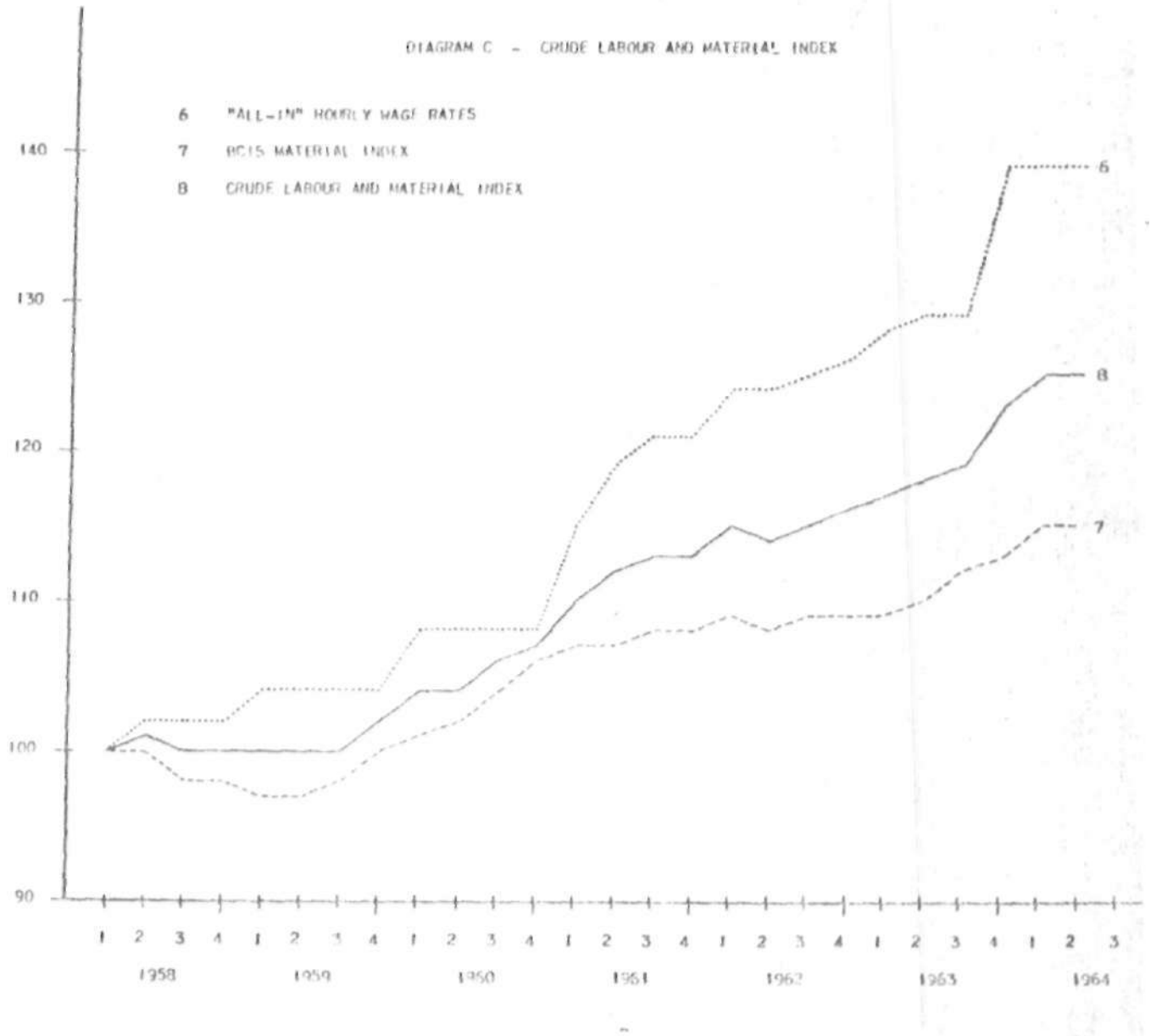


FIG. 1.03

Section 2 - Crude Labour and Material Index

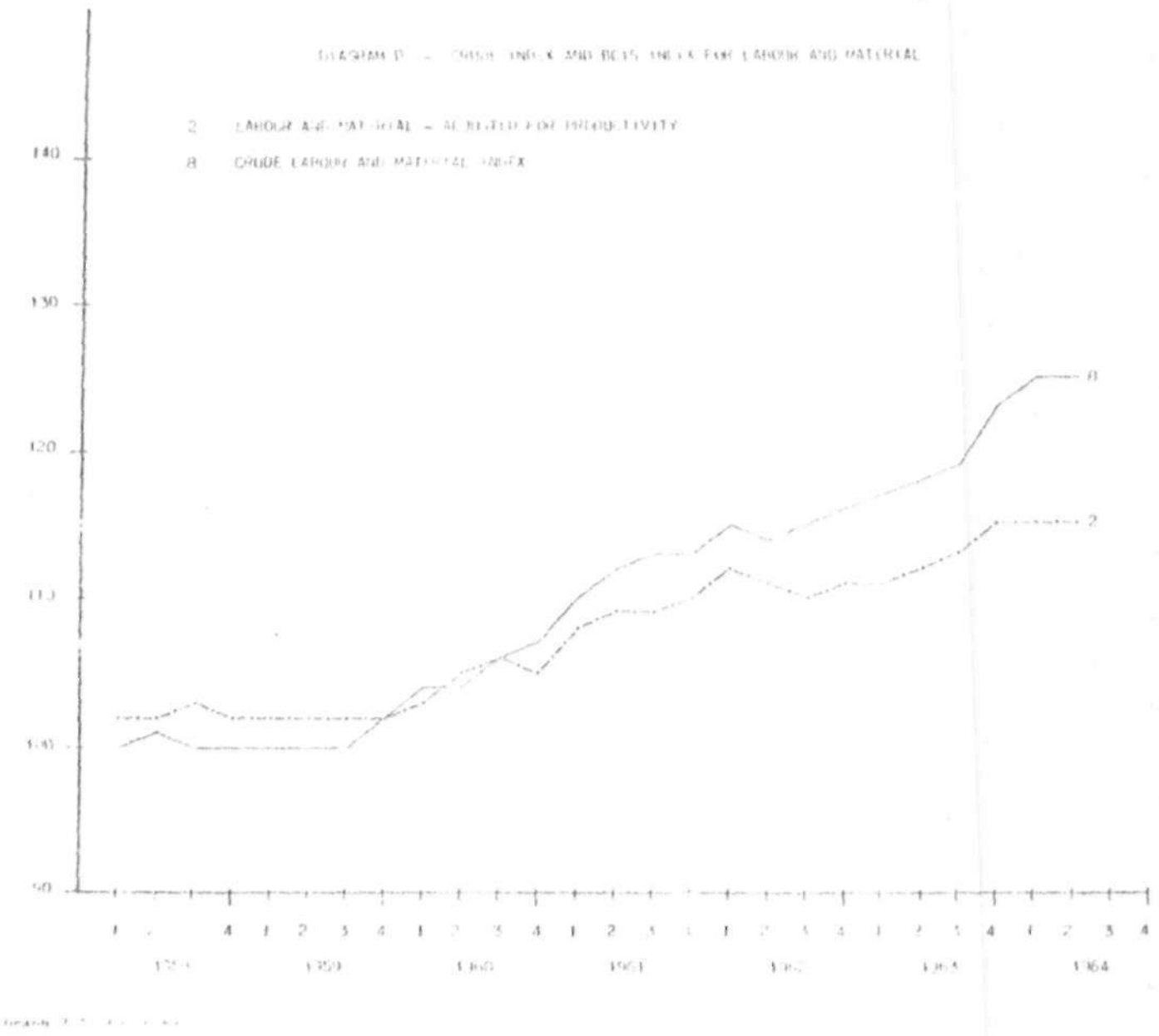
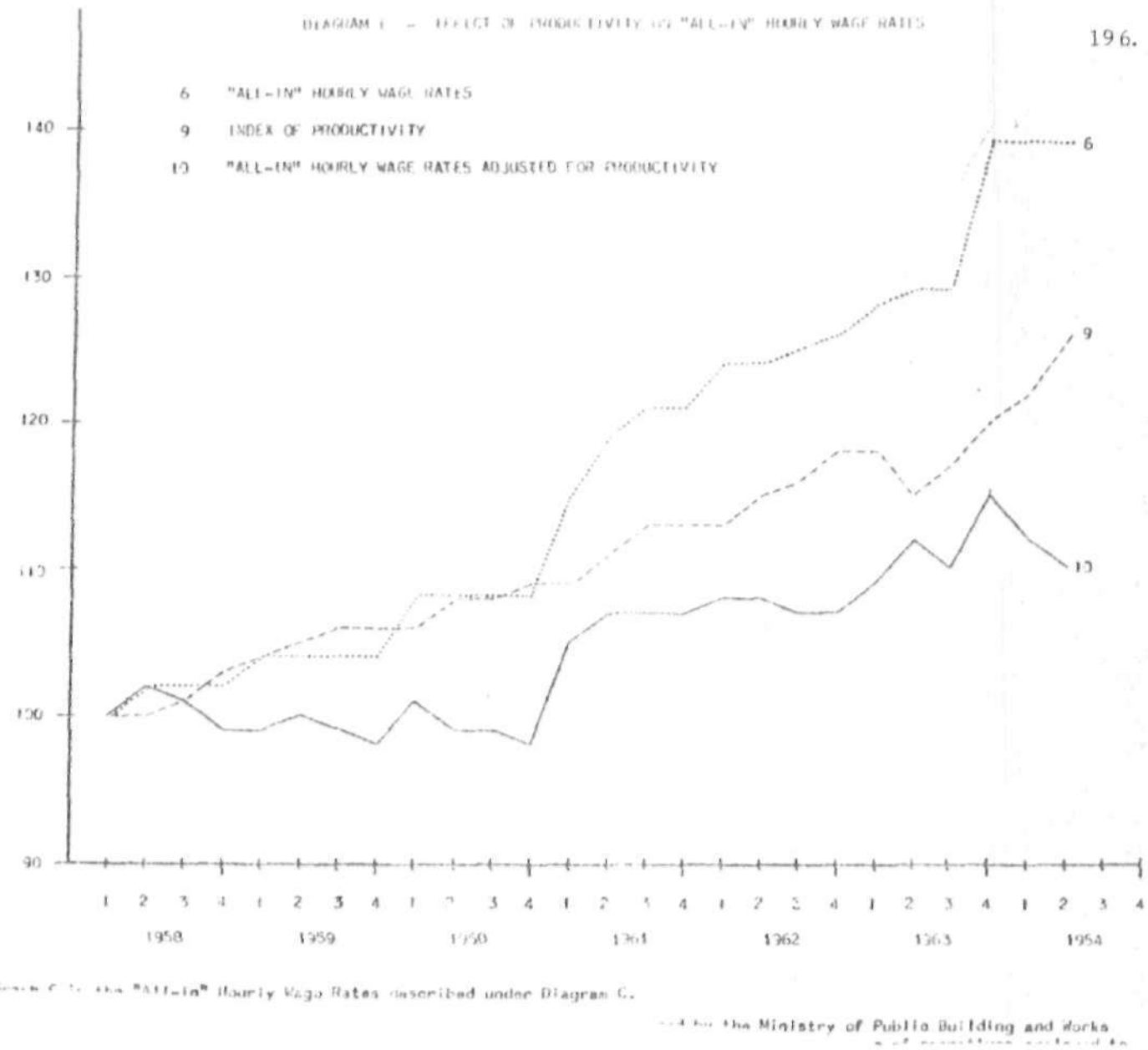


FIG. 1.04



Graph C is the "All-in" Hourly Wage Rates described under Diagram C.

...by the Ministry of Public Building and Works

FIG. 1.05

Ba 7
Cost Indices - 7
February 1972
(superseding July 1971)

BUILDING COST INDICES - 1963 TO DATE

(BASE ELEMENTS)

1963 = 100

Table Seven - Foundations Classes A & B

Year	1963	1964	1965	1966	1967	1968	1969	1970	1971
Qtr.									
i	129	138	143	145	143	154	157	170	192
ii	132	137	143	146	151	155	159	173	194
iii	132	137	144	147	152	155	162	177	200
iv	135	140	143	147	152	156	165	184	204

Table Eight - Foundations Classes C & D

1963	1964	1965	1966	1967	1968	1969	1970	1971
131	140	147	148	151	158	161	170	199
134	142	147	149	153	159	162	173	196
135	143	148	150	154	159	164	179	203
137	144	147	150	157	159	167	184	207

Table Nine - Superstructure Class A

Year	1963	1964	1965	1966	1967	1968	1969	1970	1971
Qtr.									
i	130	138	147	148	151	157	160	175	193
ii	132	141	147	151	152	158	162	178	200
iii	132	141	147	151	152	158	166	182	206
iv	134	141	146	151	151	159	169	184	210

Table Ten - Superstructure Class B

1963	1964	1965	1966	1967	1968	1969	1970	1971
132	139	148	149	151	158	161	175	197
132	141	148	150	153	159	162	178	199
133	141	148	150	155	159	166	182	206
135	143	147	150	157	160	170	184	210

Table Eleven - Superstructure Class C

Year	1963	1964	1965	1966	1967	1968	1969	1970	1971
Qtr.									
i	132	142	152	153	156	164	163	178	199
ii	134	145	153	154	159	166	170	182	205
iii	136	145	153	155	160	166	173	189	212
iv	138	148	152	156	159	167	176	194	216

Table Twelve - Superstructure Class D

1963	1964	1965	1966	1967	1968	1969	1970	1971
131	140	147	148	151	158	161	173	195
133	142	147	149	154	159	163	177	200
134	142	147	150	154	159	166	179	206
136	144	146	150	157	160	169	186	210

Table Thirteen - Internal Finishes

Year	1963	1964	1965	1966	1967	1968	1969	1970	1971
Qtr.									
i	129	137	144	144	147	153	157	162	195
ii	131	139	144	145	151	155	159	170	198
iii	131	139	144	146	151	155	161	174	196
iv	134	141	143	146	153	156	164	180	199

Table Fourteen - Fittings

1963	1964	1965	1966	1967	1968	1969	1970	1971
130	140	152	153	154	165	170	180	199
132	143	151	152	156	167	175	185	202
132	143	151	153	157	165	176	192	211
135	141	150	153	160	168	175	193	215

Table Fifteen - Services

Year	1963	1964	1965	1966	1967	1968	1969	1970	1971
Qtr.									
i	133	143	157	156	154	166	173	189	201
ii	135	145	155	159	160	169	177	191	208
iii	137	147	153	160	160	169	183	194	215
iv	138	152	154	159	165	170	187	199	219

Table Sixteen - External Works

1963	1964	1965	1966	1967	1968	1969	1970	1971
133	142	150	152	155	163	169	186	197
135	144	151	153	158	164	167	173	205
137	145	150	154	159	165	170	187	211
140	147	150	154	162	165	177	191	214

NOTES: 1. Tables include the adjustments shown in Table Nine for fluctuations and also allow for market factors.

2. Figures for the two most recent quarters are provisional.

FIG. 1.06

PROCEDURE FOR UPDATING PRICES FROM AN OLD TENDER FOR BUILDING WORK USING THE B.C.I.S. COST INDEX.

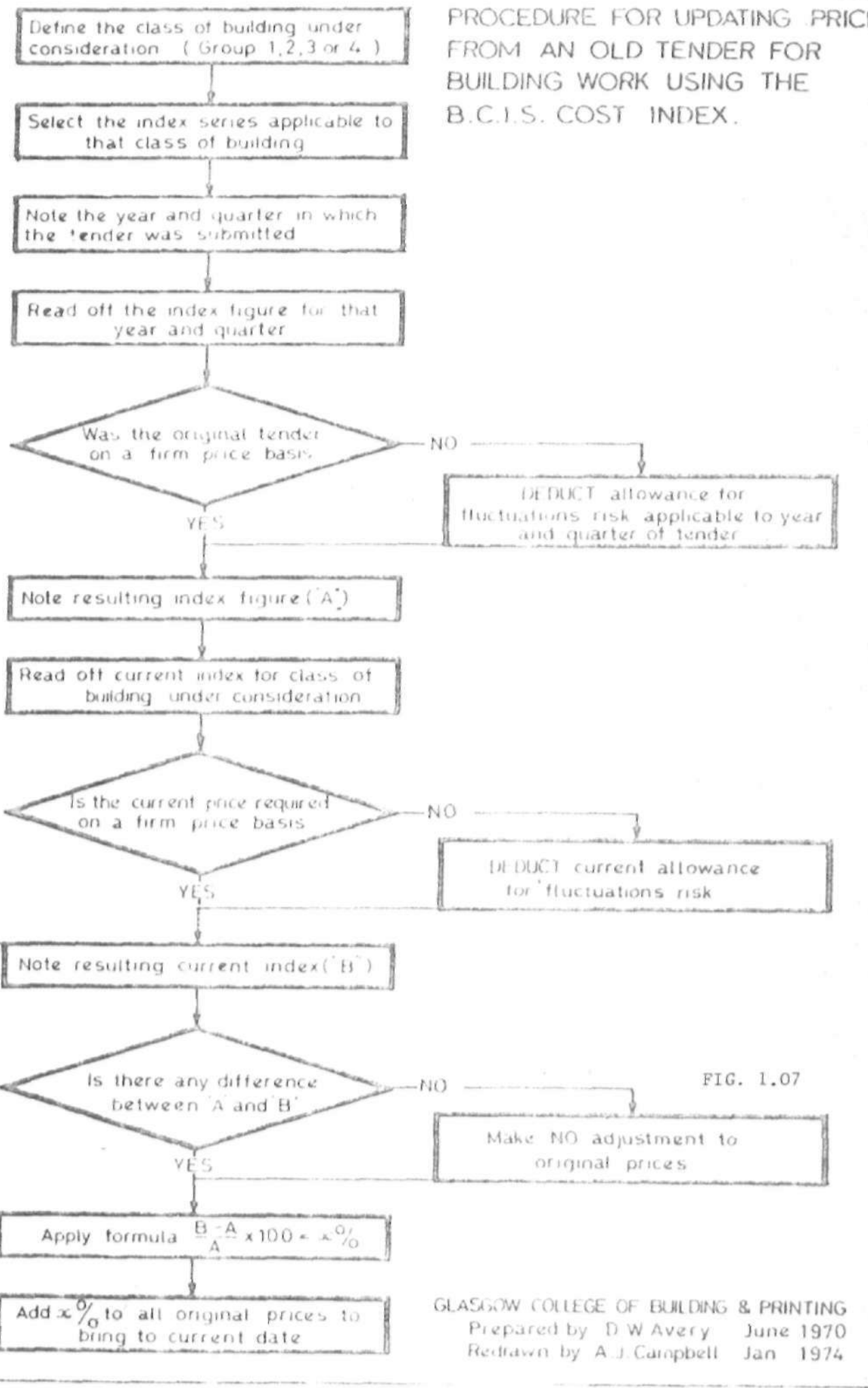
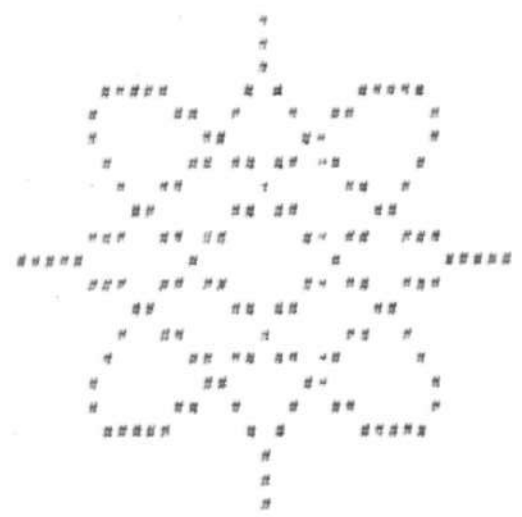


FIG. 1.07

GLASGOW COLLEGE OF BUILDING & PRINTING
Prepared by D W Avery June 1970
Redrawn by A J Campbell Jan 1974



COMPUTER CENTRE

AHMADU BELLO UNIVERSITY

ZARIA

JOB : QUANTITY SUR

NAME: MCCARTHY J.

DATE: 26/11/75



JOB QUANTITY SUR,CR5004,MCCARTHY J. RUN BY GEORGE 2/MK9E ON 26/11/75 AT 17.43

LISTING CARDS

VOLUME 3000

****

```
      C  GENERAL LABOUR
           CALL ZPGET
           CALL ZPGNG(20)
       999 FORMAT(101X,5H-----)
           WRITE(6,1)
         1 FORMAT(11X,29HGENERAL LABOUR - COST PER DAY,64X,1HK)
           JCOUNT = 0
      1000 JCOUNT = JCOUNT + 1
           READ(1,900)IRC
       900 FORMAT(I5)
           WRITE(6,3) IRC
         3 FORMAT(16X,10HBASIC COST,74X,I5)
           WRITE(6,999)
           IPD = IRS * 0.05 + 0.5
           WRITE(6,4) IPD
         4 FORMAT(16X,23HPROVIDENT FUND ALLOW 5%,61X,I5)
           ISP = IRS * 0.0433 + 0.5
           WRITE(6,5) ISP
         5 FORMAT(16X,83HSICK PAY - 7 DAYS EVERY SIX MONTHS, 6 * 4.5 WEEKS =
        127 WEEKS * 6 = 162 WORKING DAYS/20X,19H7/162 * 100 = 4.33%,61X,I5)
           IHS = IRS * 0.025 + 0.5
           WRITE(6,6) IHC
         6 FORMAT(16X,47HHOSPITAL VISITS - 10% OF STAFF, 2 HOURS PER DAY/20X,
          12HH1/10 * 2/8 * 100 = 2.5%,57X,I5)
           ITS = IRS * 0.03 + 0.5
           WRITE(6,7) ITC
         7 FORMAT(16X,29HGOVERNMENT TRAINING SCHEME 3%,55X,I5)
           IAH = IRS * 0.034 + 0.5
           WRITE(6,8) IAH
         8 FORMAT(16X,75HANNUAL HOLIDAYS - ALLOW AN AVERAGE OF 10 DAYS PER YE
        1AR, ONE YEAR = 365 DAYS/20X,50H5SUNDAYS 52, PUBLIC HOLIDAYS 9, ANNU
        2AL HOLIDAYS 10 = 71 DAYS/20X,18HWORKING DAYS = 294/20X,19H10/294 *
        3 100 = 3.4%,46X,I5)
           IR = IRS * 0.124 + 0.5
           WRITE(6,9) IR
         9 FORMAT(16X,47HRAINS - ALLOW ONE HOUR PER DAY DURING JULY AND AUGUS
        1T FOR LOST TIME/20X,17HJULY     = 31 DAYS/20X,17HAUGUST   = 31 DAYS/
        220X,7H62 DAYS/20X,17HSUNDAYS =  9 DAYS/30X,29H53 * 1 = 53 HOURS, S
        3AY 7 DAYS/20X,18H7/294 * 100 = 2.4%,62X,I5)
           IPH = IRS * 0.031 + 0.5
           WRITE(6,10) IPH
        10 FORMAT(16X,33HPUBLIC HOLIDAYS - 9 DAYS PER YEAR/20X,18H9/294 * 100
        1 = 3.1%,62X,I5)
           ILA = 2
           WRITE(6,11) ILA
        11 FORMAT(16X,68HLEAVE ALLOWANCE - 50K PER DAY WHILE ON ANNUAL LEAVE
        1= 10 * 50K / 294,16X,I5)
           ICI=IRS + IPD + ISP + IHS + ITS + IAH + IR + IPH + ILA
           IF(JCOUNT.EQ.2) GO TO 8000
           ICLA = ICI
           WRITE(6,999)
           WRITE(6,12) ICI
        12 FORMAT(16X,35HCOST PER LABOURER FOR AN 8 HOUR DAY,60X,I5)
           WRITE(6,999)
      C
      C
           CALL ZPGNG(21)
```

```
C  TRADESMAN
      WRITE(6,13)
   13 FORMAT(////11X,33HTRADESMAN OR ARTISAN COST PER DAY,60X,1HK)
      GO TO 1000
 8000 WRITE(6,909)
      WRITE(6,14) ICL
   14 FORMAT(16X,43HCOST OF TRADESMAN OR ARTISAN PER 8 HOUR DAY,41X,I5)
      WRITE(6,909)
      ICLB = ICL
C
C
      CALL ZPGNG(21)
C EXCAVATE OVER SITE AVERAGE 6" DEEP AND LEVEL
      WRITE(6,16)
   16 FORMAT(////11X,54HEXCAVATE OVER SITE AVERAGE 6"DEEP AND SPREAD AND
     1LEVEL,39X,1HK)
      WRITE(6,17)
   17 FORMAT(1H ,15X,16HLABOUR DIGGING)
      WRITE(6,4000) ICLB,ICLB
      NLAB=12
      ILD=NLAB*ICLA
      WRITE(6,4007) NLAB,ICLA,ILD
      ILD=ILD+ICLB
      WRITE(6,4010) ILD
      ITA=0.05*ILD+0.5
      WRITE(6,4011) ITA
      ICG=ILD+ITA
      WRITE(6,19)ICG
   19 FORMAT(20X,20HCOST OF GANG PER DAY,30X,I5)
      WRITE(6,20)
   20 FORMAT(1H ,15X,40HOUTPUT PER DAY 3C.YD PER MAN 12+3=36C.YD)
      ICY=ICG/36
      WRITE(6,21) ICY
   21 FORMAT(1H ,15X,14HCOST PER C.YD.,71X,I4)
      WRITE(6,22)
   22 FORMAT(1H ,15X,30HLABOUR SPREADING AND LEVELLING)
      WRITE(6,4006) ICLA,ICLA
      ITA=0.05*ICLA+0.5
      WRITE(6,4011) ITA
      ILS=ICLA+ITA
      WRITE(6,4010) ILS
      WRITE(6,23)
   23 FORMAT(1H ,15X,18HOUTPUT P.D.=4C.YD.,67X,I4)
      ILP=ILS/4
      WRITE(6,24)ILP
   24 FORMAT(16X,14HCOST PER C.YD.,70X,I5)
      ILE = ILP +ICY
      WRITE(6,25)ILE
   25 FORMAT(1H ,15X,22HNET COST OF EXCAVATION,63X,I4)
      IGP=0.25*ILE
      WRITE(6,26)IGP
   26 FORMAT(16X,16HG.O.H. & P., 25%,60X,I5)
      IPY=ILE + 0.25*ILP
      WRITE(6,24) IPY
      IPS=IPY/6
      WRITE(6,909)
      WRITE(6,28)IPS
   28 FORMAT(1H ,15X,22HCOST PER SQ.YD.6"THICK,63X,I4)
      WRITE(6,909)
```

```
C
C
      CALL ZPGNG(11)
C  EXCAVATION > 6" DEEP
      WRITE(6,29)                                                          94
   29 FORMAT(///11X,47HEXCAVATE SURFACE TRENCH NOT EXCEEDING 5 FT DEEP,    95
     1 46X,1HK)
      WRITE(6,47)
      WRITE(6,4000) ICLB,ICLB
      NLAB=12
      ILD=NLAB*ICLA
      WRITE(6,4007) NLAB,ICLA,ILD
      ILD=ILD+ICLB
      WRITE(6,4010) ILD
      ITA=0.05*ILD+0.5
      WRITE(6,4011) ITA                                                96
      ICG=ILD+ITA
      WRITE(6,103)ICG                                                  96
      WRITE(6,3000)                                                    97
 3000 FORMAT(1H ,15X,30HOUTPUT PER DAY = 3C.YD.*12 =36)                97A
      IYC = ICG/36                                                     98
      WRITE(6,24) IYC                                                  99
      IGP=0.25*IYC                                                     100
      WRITE(6,26)IGP                                                   101
      IPY = IYC +IGP                                                   102
      WRITE(6,999)
      WRITE(6,24) IPY                                                  103
      WRITE(6,999)
C
C
      CALL ZPGNG(18)
C  SURPLUSES EXCAVATED MATERIALS
      WRITE(6,30)                                                      104
   30 FORMAT(///11X,66HRETURN FILL AND RAM OR SPREAD AND LEVEL SURPLUS E  105
     1XCAVATED MATERIAL,27X,1HK)                                       106
      WRITE(6,47)
      WRITE(6,4000) ICLB,ICLB
      NLAB=12
      ILD=NLAB*ICLA
      WRITE(6,4007) NLAB,ICLA,ILD
      ILD=ILD+ICLB
      WRITE(6,4010) ILD
      ITA=0.05*ILD+0.5
      WRITE(6,4011) ITA                                                107
      ICG=ILD+ITA
      WRITE(6,103)ICG                                                  107
      WRITE(6,3002)                                                    108
 3002 FORMAT(16X,34HOUTPUT PER DAY = 4 C.YD. * 12 = 48 )               108
      ICY = ICG/48                                                     109
      WRITE(6,21)ICY                                                   110
      IGP = 0.25*ICY                                                   111
      WRITE(6,26)IGP                                                   112
      IPY =ICY +IGP                                                    113
      WRITE(6,999)
      WRITE(6,24) IPY                                                  114
      WRITE(6,999)
C
C
C  COST OF CONCRETE MIXER
```

```
      WRITE(6,31)                                                       115
   31 FORMAT(///11X,50HCOST OF OWNING AND OPERATING A 10/7 CONCRETE MIXE 116
     1R,43X,1H$)                                                        7
      WRITE(6,32)                                                       118
   32 FORMAT(1H ,15X,12HCAPITAL COST)                                   119
      READ(1,2103)ICM                                                   120
 2103 FORMAT(I6)                                                        121
      WRITE(6,33)ICM                                                    122
   33 FORMAT(16X,22HCOST OF CONCRETE MIXER,61X,16)                      123
      WRITE(6,900)                                                     123B
      WRITE(6,34)                                                       124
   34 FORMAT(1H ,15X,41HDEPRECIATION ON AVERAGE LIFE OF 8,00HOURS)      125
      ICH=ICM/8000                                                      126
      WRITE(6,35)ICH                                                    127
   35 FORMAT(1H ,15X,13HCOST PER HOUR,72X,I4)                           128
      ITA = 0.10*ICH                                                    129
      WRITE(6,36)ITA                                                    130
   36 FORMAT(1H ,15X,32HINTEREST,TAXES,AND INSURANCE 10%,53X,I4)        131
      IRM = 0.20*ICH                                                    132
      WRITE(6,37)IRM                                                    133
   37 FORMAT(16X,28HREPAIRS AND MAINTAINANCE 20%,56X,I5)                134
      IHO = ITA +ICH +IRM                                              135
      WRITE(6,38)IHO                                                  136
   38 FORMAT(1H ,15X,20HCOST PER HOUR TO OWN,65X,I4)                    137
      WRITE(6,39)                                                       138
   39 FORMAT(1H ,15X,14HOPERATING COST)                                 139
      IDO = 45 * 1.5                                                    140
      WRITE(6,40)IDO                                                    141
   40 FORMAT(1H ,15X,52HFUEL PER RHOUR DAY =1.5GAL,DIESEL OIL OF 45K PER 142
     1GAL.,33X,I4)                                                      143
      IIO=90*1.5                                                        144
      WRITE(6,41)IIO                                                    145
   41 FORMAT(1H ,15X,47HLUBRICATING OIL 1.5GALS.PER WEEK AT 90K PER GAL, 146
     13PX,I4)                                                           147
      IID =IIO/5                                                        148
      WRITE(6,42)IID                                                    149
   42 FORMAT(1H ,15X,23HLUBRICATING OIL PER DAY,62X,I4)                 150
      IOH = (IDO + IID)/8                                               151
      WRITE(6,43)IOH                                                    152
   43 FORMAT(1H ,15X,26HCOST OF OPERATING PER HOUR,59X,I4)              153
      IOP=IOH+IHO                                                       154
      WRITE(6,900)                                                     155
      WRITE(6,44)IOP                                                    156
   44 FORMAT(1H ,15X,37HCOST OF OWNING AND OPERATING PER HOUR,47X,I5)
C
C
      CALL ZPGNG(13)
C  COST OF MIXING CONCRETE
      WRITE(6,45)                                                       158
   45 FORMAT(11X,48HCOST OF MIXING CONCRETE WITH 10/7 CONCRETE MIXER,45X 159
     1,1H$)                                                             159
      IHP=IOP*8                                                         161
      WRITE(6,46)IHP                                                    162
   46 FORMAT(1H ,15X,40HHIRE OF 10/7 MIXER PER DAY 8 HRS PER DAY,45X,I4) 162
      WRITE(6,47)                                                       163
   47 FORMAT(1H ,15X,6HLABOUR)                                          164
      ICL =8*ICLA                                                       165
```

```
      NON=8                                                              144
      WRITE(6,4007)NON,ICIA,ICL
      ITO=0.05*ICL                                                       168
      WRITE(6,4011)ITO                                                   169
      ICO=ITO+ICL+IHO                                                    171
      WRITE(6,51)ICO                                                     174
   51 FORMAT(1H ,15X,24HOUTPUT PER DAY = 20 YDS.,31X,I4)                 175
      ICY= ICO/20                                                        176
      WRITE(6,999)
      WRITE(6,24) ICY                                                    177
      WRITE(6,999)
C
C
      CALL ZPENG(13)                                                     178
      WRITE(6,53)                                                        179
   53 FORMAT(///11X,33HCOST OF PLACING CONCRETE IN FOUNDATION,55X,1HK)   180
      WRITE(6,47)                                                        181
      WRITE(6,54)                                                        183
   54 FORMAT(1H ,15X,61HWHEELING IN BARROWS & LABOURERS,PLACING ZLABOURE 184
     1RS=ALABOURERS)                                                     185
      IC1=ICL+6                                                          188
      NON=6                                                              189
      WRITE(6,4007)NON,ICIA,ICL                                          190
      ITO=ICL*0.05                                                       191
      WRITE(6,4011)ITO                                                   192
      ICO =ITO+ICL                                                       193
      WRITE(6,59)ICO                                                     194
   59 FORMAT(16X,25HCOST OF LABOURERS PER DAY,59X,I5)                    195
      WRITE(6,60)                                                        196
   60 FORMAT(1H ,15X,21HOUTPUT PER DAY =5C,YD)                           197
      ITY = ICO/6                                                        198
      WRITE(6,999)
C  COST OF PLACING CONCRETE IN FOUNDATION
      WRITE(6,61) ITY                                                    199
   61 FORMAT(16X,48HCOST PER C.YD. OF PLACING CONCRETE IN FOUNDATION,36X  200
     1,I5)                                                               200
      WRITE(6,999)
C
C
      CALL ZPENG(14)                                                   201A
C  COST OF PLACING CONCRETE IN SUPERSTRUCTURE
      WRITE(6,62)                                                        201
   62 FORMAT(///11X,33HCOST OF PLACING IN SUPERSTRUCTURE,60X,1HK)        202
      WRITE(6,47)                                                        203
      WRITE(6,64)                                                        205
   64 FORMAT(1H ,15X,60HWHEELING IN BARROW ZLABOURERS PLACING ZLABOURERS 206
     1= ALABOURERS)                                                      207
      ICG = 9 + ICL                                                      208
      NON=9                                                              209
      WRITE(6,4007)NON,ICIA,ICG                                          210
      ICM = 1+ ICLR                                                      211
      WRITE(6,4040)ICIB,ICLR                                             202
      ITC = ICG + ICM                                                    214
      ITO = 0.05 *ICC                                                    217
      WRITE(6,4011)ITO                                                   218
      ICO = ITO + ICC                                                    220
      WRITE(6,19)ICO                                                     221
      WRITE(6,70)                                                        223
   70 FORMAT(1H ,15X,21HOUTPUT S C.YD.PER DAY)                           224
```

```
      WRITE(6,999)
      WRITE(6,71) IDD                                                    226
   71 FORMAT(16X,52HCOST PER C.    OF PLACING CONCRETE IN SUPERSTRUCTURE    227
     1,32X,I5)                                                           227
      WRITE(6,999)
C
C
      CALL ZPGNG(18)                                                 228A
C  COST OF CEMENT ON SITE
      WRITE(6,72)                                                        228
   72 FORMAT(////11X,22HCOST OF CEMENT ON SITE,71X,1HK)                  229
      READ(1,2104)ICK                                                    230
 2104 FORMAT(I5)                                                         231
      WRITE(6,73)ICK                                                     232
   73 FORMAT(16X,40HCOST OF CEMENT PER TON EX.RAILWAY KADUNA,44X,I5)      233
      WRITE(6,999)                                                   233B
      WRITE(6,74)                                                        234
   74 FORMAT(1H ,15X,16HDELIVERY TO SITE)                                235
      READ(1,2105)IHL                                                    236
 2105 FORMAT(I5)                                                         237
      WRITE(6,75)IHL                                                     238
   75 FORMAT(16X,21HHIRE OF LORRY PER DAY,63X,I5/16X,57HOUTPUT PER DAY -  239
     1 4 TRIPS OF 5 TONS EACH = 20 TONS PER DAY)                         240
      WRITE(6,999)                                                   240B
      ICL = IHL/20                                                       241
      WRITE(6,76)ICL                                                     242
   76 FORMAT(16X,12HCOST PER TON,72X,I5)                                 243
      WRITE(6,77)                                                        244
   77 FORMAT(1H ,15X,28HLABOUR LOADING AND UNLOADING)                    245
      ICL = 4*ICLA                                                       246
      NON=4                                                          247
      WRITE(6,4007)NON,ICLA,ICL                                      248
      WRITE(6,79)                                                    249
   79 FORMAT(1H ,15X,25HOUTPUT OF 20 TONS PER DAY)                       250
      ITC = ICL/20                                                       251
      WRITE(6,80)ITC                                                     252
   80 FORMAT(16X,12HCOST PER TON,72X,I5)                                 253
      ICS = ICT + ITC +ICK                                               254
      WRITE(6,81)ICS                                                     255
   81 FORMAT(16X,20HCOST PER TON ON SITE,64X,I5)                         256
      ICH = ICS/20                                                       257
      WRITE(6,999)
      WRITE(6,82)ICH                                                     258
   82 FORMAT(16X,20HCOST PER CWT ON SITE,64X,I5)                         259
      WRITE(6,999)
C
C
      CALL ZPGNG(16)                                                 299
C  COST OF CONCRETE(2)
      WRITE(6,84)                                                        300
   84 FORMAT(////11X,35HCOST OF CONCRETE (1:3:6 - 1.5" AGG),58X,1HK)      301
      IOC=ICS*0.16                                                       302
      WRITE(6,85)IOC                                                     303
   85 FORMAT(16X,16HCEMENT 0.16 TONS,60X,I5)                             304
      READ(1,2107)ISC                                                    305
 2107 FORMAT(I5)                                                         306
      IOS=0.45*ISC                                                   309
      WRITE(6,87) ISC,IOS                                            310
```

```
      87 FORMAT(16X,16HSAND 0.45 C.YD @,I5,1HK,62X,I5/34X,3H---)
         READ(1,2100)IQA
 2100 FORMAT(I5)
         IA0=0.90*IQA
         WRITE(6,89) IQA,IA0
      89 FORMAT(16X,22HAGGREGATE 0.90 C.YD. @,I5,1HK,56X,I5/40X,3H---)
         ICN=IQC+IQS+IA0
         ISW=0.05*ICN
         WRITE(6,90)ISW
      90 FORMAT(16X,33HSTOCKPILE WASTE ON MATERIALS 5%,53X,I5)
         WRITE(6,88) ICY
      88 FORMAT(16X,24HCOST OF MIXING PER C.YD.,,60X,I5)
         ICC=ICN+ISW+ICY
         WRITE(6,999)
         WRITE(6,91)ICC
      91 FORMAT(16X,22HCOST PER C.YD AT MIXER,62X,I5)
         WRITE(6,999)
C
C
         CALL ZPGNG(14)
C  COST OF CONCRETE(3)
         WRITE(6,92)
      92 FORMAT(////11X,35HCOST OF CONCRETE (1:2:4 - 3/4" AGG),58X,1HK)
         IC0=ICS*0.23
         WRITE(6,93) ICS,IC0
      93 FORMAT(16X,18HCEMENT 0.23 TONS @,I5,1HK,60X,I5)
         IS0=0.43*IS0
         WRITE(6,94) IC0,IS0
      94 FORMAT(16X,16HSAND 0.43 C.YD @,I5,1HK,62X,I5)
         READ(1,500)IQA
  500 FORMAT(I5)
         IA0=0.85*IQA+0.5
         WRITE(6,95) IQA,IA0
      95 FORMAT(16X,22HAGGREGATE 0.85 C.YD. @,I5,1HK,56X,I5)
         IC0=IC0+IS0+IA0
         ISW=0.05*IC0+0.5
         WRITE(6,90) ISW
         WRITE(6,88) ICY
         IC0=IC0+ISW+ICY
         WRITE(6,999)
         WRITE(6,91) IC0
         WRITE(6,999)
C
C
         CALL ZPGNG(10)
C  PLAIN INSITU CONCRETE IN FOUNDATIONS
         WRITE(6,96)
      96 FORMAT(////11X,36HPLAIN INSITU CONCRETE (1:3:6 - 1.5" AGG.) IN FOUN
        1DATIONS,32X,1HK)
         WRITE(6,91)IC0
         WRITE(6,61)ITY
         IPC=IC0+ITY
         IGP=0.25*IPC
         WRITE(6,26) IGP
         IPF=IPC+IGP
         WRITE(6,999)
         WRITE(6,98)IPF
      98 FORMAT(16X,28HCOST PER C.YD. IN FOUNDATION,56X,I5)
         WRITE(6,999)
```

```
C
C
      CALL ZPGNG(10)                                                    372A
C  REINFORCED INSITU CONCRETE
      WRITE(6,99)                                                        372
   99 FORMAT(///11X,64HREINFORCED INSITU CONCRETE (1:2:4 - 3/4" AGG,) IN 373
     1 SUPERSTRUCTURE,29X,1HK)                                           374
      WRITE(6,97)ICO                                                     375
      WRITE(6,71)IOP                                                     376
      IPC =ICO+IOP                                                       377
      IGP = 0.25*IPC                                                     378
      WRITE(6,26) IGP                                                    378
      IPS =IPC + IGP                                                     379
      WRITE(6,999)                                                       380
      WRITE(6,100)IPS                                                    381
  100 FORMAT(16X,32HCOST PER C,YD, IN SUPERSTRUCTURE,52X,I5)             382
      WRITE(6,999)                                                   382A
C
C
      CALL ZPGNG(22)                                                 383A
C  1/4" DIAMETER MILD STEEL ROD
      WRITE(6,101)                                                       383
  101 FORMAT(///11X,74H1/4" DIA, MILD STEEL ROD REINFORCEMENT INCLUDING  384
     1ENDS, HOOKS, TYING WIRE,,19X,1HK/11X,57HDISTANCE BLOCK AND ORDINA  385
     2RY SPACERS IN WALL REINFORCEMENT)                                  386
      WRITE(6,102)                                                       387
  102 FORMAT(1H ,15X,11HTAKE 1 CWT,)                                     388
      READ(1,9109)IWS                                                    389
 9109 FORMAT(I5)                                                         390
      WRITE(6,103)IWS                                                    391
  103 FORMAT(16X,51H1 CWT OF 1/4" DIA, MILD STEEL ROD DELIVERED TO SITE, 392
     1 13X,I5/101X,4H----)                                              393
      ICW=0.10*IWS                                                       394
      WRITE(6,104)ICW                                                    395
  104 FORMAT(16X,22HCUTTING AND WASTE  10%,62X,I5)                       396
      ILO=ICLA/8                                                         397
      WRITE(6,105) ILO,ILO                                               398
  105 FORMAT(16X,25HLABOUR OFFLOADING  1 HR @,I5,1HK,53X,I5)             399
      READ(1,110)ITW                                                     400
  110 FORMAT(I5)                                                         401
      IWP=ITW*3                                                          402
      WRITE(6,107) ITW,IWP                                               403
  107 FORMAT(16X,35H18 GA, TYING WIRE  3 LB, PER CWT, @,I5, 9HK PER LB,, 404
     1 13X,I5/53X,3H---)                                                405
      WRITE(6,108)                                                       406
  108 FORMAT(1H ,15X,6HLABOUR)                                           407
      ILO=ICLA*1.5                                                       408
      WRITE(6,109) ICLA,ILO                                              409
  109 FORMAT(16X,19H1 LABOUR 1,5 DAYS @,I5,10HK         =,I5)            410
      IER=1.5*5                                                          411
      WRITE(6,111)IER                                                    412
  111 FORMAT(16X,34HEXTRA RATE FOR STEEL FIXER @  5K =,I5)               413
      INS =ILO +IER                                                      414
      WRITE(6,112)INS                                                    415
  112 FORMAT(52X,3H---/50X,I5)                                           416
      IFS=0.05*INS                                                   417
      INS=INS+IFS                                                        418
      WRITE(6,113) IFS,INS                                               419
  113 FORMAT(16X,12H5% FOR TOOLS,22X,I5,45X,I5)                          420
```

```
      IGP=0.25*(IMS+ICW+ILO+IMP+
      WRITE(6,26) IGP                                                    410
      IPC=IGP+IMS+ICW+ILO+IMP+INS                                        411
      WRITE(6,999)                                                       412
      WRITE(6,115)IPC                                                    414
  115 FORMAT(16X,28H1/4" DIA. MILD STEEL PER CWT,56X,I5)                 415
      WRITE(6,999)
C
C
C  1.5" DIAMETER MILD STEEL ROD
      CALL ZPENC(15)                                                     1114A
      WRITE(6,341)                                                       1114
  341 FORMAT(///11X,36H1/2" DIA. M.S ROD REINF. INCLUDING BENDS,HOOPS TY1115
     1INGWIRE,DISTANCE BLOCKS  OBD. SPACERS,/X,1HK)                      1116
      WRITE(6,102)                                                       1117
      READ(1,8011)INS                                                    1119
 8011 FORMAT(I5)                                                         1120
      WRITE(6,363)INS                                                    1121
  363 FORMAT(1H ,15X,34H1CWT OF 1/2" DIA. M.S ROD PER SITE,5X,I4/1H1X,41122
     1H-----)                                                            1122B
      ICW = 0.10 * INS                                                   1123
      WRITE(6,104) ICW                                                   1124
      ILO = ICW/8                                                        1126
      WRITE(6,365)ILO                                                    1127
  365 FORMAT(1H ,15X,22H1ABOUR OFFLOADING 1 HR,63X,I4)                   1128
      WRITE(6,401)ITW,ITW                                                1129
  401 FORMAT(16X,34H1R GA. TYING WIRE  1 LB PER CWT, 8.75,9HK PER LB.,36 1129B
     1X,I5)                                                              1129C
      ISF = ICLA + C                                                     1130
      WRITE(6,366)ISF                                                    1131
  366 FORMAT(1H ,15X,11HSTEEL FIXER,74X,I4)                              1132
      ITO = 0.05 * ISF                                                   1133
      WRITE(6,367)ITO                                                    1134
  367 FORMAT(1H ,15X,12H6% FOR TOOLS,75X,I4)                             1135
      IGP = 0.25*(ITO +ISF + ITW + ILO + ICW + IMS)                      1136
      WRITE(6,26) IGP                                                    1137
      IPC = IGP + ITO + ISF + ITW + ILO + ICW + IMS                      1139
      WRITE(6,999)
      WRITE(6,115) IPC                                                   1140
      WRITE(6,999)
C
C
C  SAWN FORMWORK
      CALL ZPENC(27)                                                     1119
      WRITE(6,116)                                                       420
  116 FORMAT(///11X,42HSAWN FORMWORK TO HORIZONTAL SOFFIT OF SLAB)       421
      WRITE(6,117)                                                       422
  117 FORMAT(1H ,15X,15HTAKE 100 SQ.FT.)                                 423
      WRITE(6,118)                                                       424
  118 FORMAT(1H ,15X,11HPREPARATION)                                     425
      READ(1,2000) ISBC                                                  426
 2000 FORMAT(I5)                                                         427
      ISB=33.33*ISBC                                                     427
      WRITE(6,314) ISBC,ISB                                              429
  119 FORMAT(16X,76HALLOW1/3 C.FT. OF TIMBER PER SQ.FT. TO INCLUDE SOFF  429
     1IT BOARDING, BEARERS AND/16X,25HSTRUTTING = 33.33 C.FT. 0.15,      430
     256X,I5/62X,6H-----)                                                431
      INP = ICLA + ICLB                                                  434
      WRITE(6,1211)INP                                                   435
```

```
      ITA = 0.05 * TNP                                                          437
      WRITE(6,122)ITA                                                           438
  122 FORMAT(16X,12HS9 FOR TOOLS,  (,I5)                                        439
      IPT=ITA+TNP+ICP                                                     44
      WRITE(6,123)IPT                                                           441
  123 FORMAT(16X,23HCOST OF PREPARED TIMBER,61X,I5)                             442
      ICU=IPT/4.0                                                         444
      WRITE(6,124)ICU                                                           445
  124 FORMAT(16X,28HCOST PER USE, ASSUME 4 TIMES,56X,I5)                        446
      INU = 0.10 * ICU                                                          447
      WRITE(6,125)INU                                                           447
  125 FORMAT(16X,21HWASTE ON EACH USE ,10X,63X,I5)                              449
      WRITE(6,126)                                                              450
  126 FORMAT(1H ,15X,21HERECTING AND STRIKING)                                  451
      IES = 1*ICLR +4*ICLA                                                      452
      WRITE(6,127)IES                                                           455
  127 FORMAT(16X,33HLABOUR FOR ERECTING AND STRICKING,51X,I5)                   454
      ITA = 0.05* IES                                                          454A
      WRITE(6,128) ITA                                                          456
      READ(1,3203) INRC                                                         458
 3203 FORMAT(I5)                                                                459
      INR=11*INRC                                                               459
      WRITE(6,129) INRC,INR                                                     460
  129 FORMAT(16X,36HNAILS, BOLTS, MOULDOIL: 11 SQ.YDS,A,I5,1HX,42X,I5/55 461
     1X,2H--)                                                                  461B
      INES = INP + ITA + IES +ICU +INU                                          462
      IGP = 0.25 * TNES                                                         465
      WRITE(6,26) IGP                                                           466
      ITC = IGP + TNES                                                          468
      WRITE(6,999)
      WRITE(6,132)ITC                                                           469
  132 FORMAT(16X,19HCOST PER 100 SQ.FT.,65X,I5)                                 470
      ITCA = ITC/100                                                            471
      WRITE(6,999)
      WRITE(6,133)ITCA                                                          472
  133 FORMAT(16X,15HCOST PER SQ.FT.,69X,I5)                                     473
      ITCR =ITCA * 9                                                            474
      WRITE(6,999)
      WRITE(6,134)ITCR                                                          475
  134 FORMAT(16X,15HCOST PER SQ.YD.,69X,I5)                                     476
      WRITE(6,999)
C
C
C  EXTRA OVER SHUTTERED FACES
      CALL PAGE(24)                                                       480
      WRITE(6,135)                                                              480
  135 FORMAT(////11X,59HEXTRA OVER SHUTTERED FACED OF CONCRETE FOR FAIR F       481
     1ACE FINISH,34X,1HX)                                                     482
      WRITE(6,117)                                                              483
      WRITE(6,137)                                                              485
  137 FORMAT(1H ,15X,70HALLOW HARD BOARD LINING TO FMWK AND RUBBING DOWN        486
     1AFTER FMWK IS STRIPPED)                                                  487
      READ(1,3204) IFAC                                                         488
 3204 FORMAT(I5)                                                                489
      IFA=100*IFAC                                                             489B
      WRITE(6,138) IFAC,IFA                                                     490
  138 FORMAT(16X,26H100 SQ.FT. OF HARD BOARD ,I5,1HX,52X,I5/43X,4H====) 491
      ICU=IFA/4.0                                                         492
```

```
      WRITE(6,174) ICN                                                  492
      IVU=0.1*ICU+0.5                                                   490
      WRITE(6,175) IWU                                                  497
      WRITE(6,147)                                                      499
      WRITE(6,999)                                                      499
      WRITE(6,174) INSV
      WRITE(6,999)
C
C     A" HALLOW CONCRETE BLOCK
      CALL ZPRACE(31)                                                   533
      WRITE(6,153)                                                      534
  153 FORMAT(//11X,'5H6"HOLLOW CONCRETE BLOCK WALLING IN CEMENT MORTAR  535
     1(1:6))
      WRITE(6,154)                                                      537
  154 FORMAT(1H ,15V,24HCOST OF CEMENT MORTAR(1:6))                     538
      WRITE(6,M1)ICC
      IFTA=0.27*ICS                                                     540
      WRITE(6,155)ICTA                                                  541
  155 FORMAT(1H ,15V,26HCOST OF 0.2210NS OF CEMENT,59X,I4)              542
      ISSA = 1.21*ICC                                                   544
      WRITE(6,15A) ISC,ISSA                                             545
  156 FORMAT(19X,17USAND 1.21 C.YD. @,15,1HX,41X,I5)                    546
      INS=ISSA+ICTA                                                     547
      WRITE(6,157)I=S                                                   548
  157 FORMAT(1H ,15V,27HNET COST OF SAND AND CEMENT,5RX,I4)             549
      ISPU=INS*0.05                                                     550
      WRITE(6,0N) I=PU                                                  551
      BFAD(1,1210)I=M                                                   553
 1210 FORMAT(I5)                                                        554
      WRITE(6,158)I=M                                                   555
  158 FORMAT(1H ,15V,27HALLOW FOR MX6 MORTAR P.C.YD.,,57X,I4)           556
```

```
      IPY=IMM*ISPW*INS                                                  557
      WRITE(6,91) IPY                                                   558
      IPF=IPY/27                                                        560
      WRITE(6,161)IPF                                                   561
  161 FORMAT(16X,23HCOST PER C.FT. AT MIXER,61X,I5)                     562
      WRITE(6,112)                                                      563
      WRITE(6,163)                                                      565
  163 FORMAT(1H ,15X,20HBLOCK SIZE 18"*9"*6")                           566
      READ(1,3211)ICB                                                   566
 3211 FORMAT(I5)                                                        568
      WRITE(6,164)ICB                                                   569
  164 FORMAT(1H ,15X,50HNO.OF BLOCKS REQ'D 100/(1.5*0.75)=89BLOCKS ON SI 570
     1TE,35X,I4)                                                        571
      WRITE(6,999)                                                      571A
      ICWA=0.05*ICB                                                     572
      WRITE(6,165)ICWA                                                  573
  165 FORMAT(16X,8HWASTE 5%,76X,I5)                                     573
      READ(1,3212)ICM                                                   575
 3212 FORMAT(I5)                                                        576
      WRITE(6,166)ICM                                                   577
  166 FORMAT(1H ,15X,26HCOST OF 5.5C.FT. OF MORTAR,59X,I4)              578
      ICWR=0.10*ICM                                                     579
      WRITE(6,167)ICWR                                                  580
  167 FORMAT(16X,9HWASTE 10%,75X,I5)                                    581
      WRITE(6,47)                                                       582
      ITA=0.05*2*(ICLA+ICLB)                                            584
      ICG=ITA*2*(ICLA+ICLB)                                             585
      WRITE(6,168)ICG,ITA                                               586
  169 FORMAT(1H ,15X,32HCOST OF 2 MASONS AND 2 LABOURERS,53X,I4/16X,18H5 587
     1 %     FOR TOOLS,67X,I4)                                          588
      WRITE(6,170)                                                      589
  170 FORMAT(1H ,15X,20HOUTPUT 100BLOCKS P.D)                           590
      ICSF=ICG/100*89                                                   591
      WRITE(6,132) ICSF                                                 592
      INS=ICSF+ICWR+ICM+ICWA+ICB                                        594
      WRITE(6,172)INS                                                   595
  172 FORMAT(1H ,15X,22HNET SUM COST OF LABOUR,62X,I5)                  596
      IGP=0.25*INS                                                      597
      WRITE(6,26) IGP                                                   598
      ICSY=(IGP+INS)/100*9                                              600
      WRITE(6,999)                                                      601
      WRITE(6,134) ICSY
      WRITE(6,999)
C
C
C  9" HOLLOW CONCRETE BLOCK
      CALL ZDONG(19)                                                    606A
      WRITE(6,175)                                                      606
  175 FORMAT(///11X,45H9"HOLLOW CONCRETE BLOCK WALLING IN CEMENT MORTAR 607
     1((1:6),58X,1HK)                                                   608
      WRITE(6,117)                                                      609
      READ(1,4012)ICB                                                   612
 4012 FORMAT(I5)                                                        613
      WRITE(6,177)ICB                                                   614
  177 FORMAT(1H ,15X,22HCOST PER BLOCK ON SITE,63X,I4)                  615
      WRITE(6,999)                                                      615B
      ICBA=BY*ICB                                                       616
      WRITE(6,178)ICBA                                                  617
```

```
      178 FORMAT(1H ,15X,24HCOST OF  BLOCKS ON SITE,61X,I4)
          ICWA=0.05*ICR
          WRITE(6,165) ICWA
          READ(1,6213)ICM
     6213 FORMAT(I5)
          WRITE(6,184)ICM
      180 FORMAT(1H ,15X,24HCOST PER C.FT. OF MORTAR,61X,I4)
          ICMA= 8.25*IC
          WRITE(6,181)ICMA
      181 FORMAT(1H ,15X,26HCOST OF 8.25C.FT.OF MORTAR,59X,I4)
          ICMB=0.10*ICMA
          WRITE(6,167) ICMB
          ICMBA=ICMB/2
          WRITE(6,168)ICG,ICMBA
          WRITE(6,170)
          WRITE(6,132) ICSF
          IGP =0.25*(ICSF+ICWB+ICMA+ICWA+ICBA)
          WRITE(6,26) IGP
          INSF=IGP+ICSF+ICWB+ICMA+ICWA+ICBA
          WRITE(6,999)
          WRITE(6,132) INSF
          ICSFB=(INSF/100)*9
          WRITE(6,999)
C
C
C  EXTRA OVER HOLLOW CONCRETE
          CALL ZPGNG(16)
          WRITE(6,186)
  186 FORMAT(//11X,52HEXTRA OVER HOLLOW CONCRETE BLOCK WALL FOR BUILDING
     1 FACE AND POINTING IN CEMENT MORTAR  (1:6))
          WRITE(6,187)
  187 FORMAT(16X,14HTAKE 10 SQ.FT.)
          WRITE(6,47)
          IMS=(0.5*ICIB)/R
          WRITE(6,189)IMS
  189 FORMAT(1H ,15X,12H1MASON 1/2HR,73X,I4)
          IIA=(0.5*ICIA)/R
          WRITE(6,190)IIA
  190 FORMAT(1H ,15X,15H1LABOURER 1/2HR,70X,I4)
          ITO=5*(IMS+IIA)/100
          IGG=ITO+IMS+IIA
          WRITE(6,19)IGG
          WRITE(6,191)ITO
  191 FORMAT(1H ,15X,12H5% FOR TOOLS,75X,I4)
          WRITE(6,192)
  192 FORMAT(1H ,15X,6HMORTAR)
          WRITE(6,193)
  193 FORMAT(1H ,15X,74HALLOW 25FT OF JOINT SIZE 1/2"*3/4"= 25*0.04*0.06
     1 =0.060U.FT. SAY 0.10CU.FT)
          WRITE(6,161)IDF
          IMP=IDF*0.10
          WRITE(6,194)IMP
  194 FORMAT(1H ,15X,23HCOST OF 0.10C.FT MORTAR,62X,I4)
          IGP=0.25*(ITO+IMP+IMS+IIA)
          WRITE(6,26) IGP
          IPI=IGP+ITO +IMP +IMS +IIA
          WRITE(6,999)
```

```
      198 FORMAT(16X,18HCOST PER 10 SQ.FT.,46X,I5)
          IPF= IPT/10
          WRITE(6,999)
          WRITE(6,133) IPF
          IPD=IPF*5
          WRITE(6,999)
          WRITE(6,134) IPD
          WRITE(6,999)
C
C
C  9" HOLLOW CONCRETE BLOCK(2)
          CALL ZPGNG(14)
          WRITE(6,199)
      199 FORMAT(///11X,85H9"HOLLOW CONCRETE BLOCK WALLING IN CEMENT MORTAR
     1(1:6) WITH ALL CAVATIES FILLED SOLID,37X,29HWITH CONCRETE(1:2:4-3/
     24"AGG) )
          WRITE(6,132) INSF
          WRITE(6,201)
      201 FORMAT(1H ,15X,29HSIZE OF CAVITY 61/2"*51/2"*9"/16X,50H2NO. CAVITI
     1ES PER BLOCK AND 80BLOCKS PER 100SQ.FT./16X,54HVOLUME OF CAVITIES=
     2.80*2*0.54*0.46*0.750.FT = 31.720.FT)
          WRITE(6,100)IPS
          IPC=(IPS*31.72)/27
          WRITE(6,202)IPF
      202 FORMAT(1H ,15X,16HCOST OF CONCRETE,69X,I4)
          ICP =IPC+INSF
          WRITE(6,999)
          WRITE(6,132) ICP
          WRITE(6,999)
          ISP=ICP/100
          WRITE(6,133) ISP
          IDP=ISP*9
          WRITE(6,999)
          WRITE(6,134) IDP
          WRITE(6,999)
C
C
C  "LIGHTSUPERSIX" CORRUGATED ASBESTOS CEMENT
          CALL ZPGNG(23)
          WRITE(6,206)
      206 FORMAT(///11X,80HLIGHTSUPERSIX CORRUGATED ASBESTOS CEMENT ROOF SHE
     1ETING FIXED TO HARDWOOD BATTENS,(3X,1HX/16X,51HWITH GALVANISED MIL
     2D STEEL DRIVE SCREWS AND WASHERS)
          WRITE(6,117)
          WRITE(6,208)
      208 FORMAT(1H ,15X,71HASSUME 10FT.LONG SHEETS,NET WIDTH=40";AREA COVER
     1ED PER SHEET = 33 C.FT.)
          READ(1,5230)IC
 5230 FORMAT(I5)
          WRITE(6,209)IC
      209 FORMAT(1H ,15X,41HCOST EX-STOCK N5.00 PER SHEET SAY ON SITE,44X,
     1I4)
          WRITE(6,999)
          IPS=(IC*100)/33
          WRITE(6,132) IPS
          INL=0.15*IPS
           WRITE(6,211)IPS
      211 FORMAT(1H ,15X,26H15% FOR WASTE AND END LAPS,59X,I4)
```

```
      READ(1,5231)ICW                                                          729
 5231 FORMAT(I5)                                                               730
      WRITE(6,212)ICW                                                          731
  212 FORMAT(1H ,15X,34HALLOW FOR DRIVE SCREWS AND WASHERS,51X,I4)             732
      WRITE(6,999)                                                             7328
      WRITE(6,47)                                                              733
      ICA=1*ICLR                                                               735
      WRITE(6,4002)ICLB,ICLR                                                   736
      ILA=2*ICLA                                                               738
      NON=2                                                                    739
      WRITE(6,4007)NON,ICLA,ILA                                                740
      ITO =0.05*(ICA+ILA)                                                      741
      WRITE(6,4011)ITO                                                         742
      ICG=ITO+ILA+ICA                                                          744
      WRITE(6,191)ICG                                                          745
      WRITE(6,218)                                                             747
  218 FORMAT(1H ,15X,25HOUTPUT 100SQ.FT. IN 4HRS.)                             748
      ICL =(ICG+4)/8                                                           749
      WRITE(6,219)ICL                                                          750
  219 FORMAT(1H ,15X,14HCOST OF LABOUR,71X,I4)                                 751
      IGP = 0.25*(ICL +ISW + IWL + IPS )                                       752
      WRITE(6,26) IGP                                                          753
      ITC = IGP +ICL +ISW +IWL + IPS                                           755
      WRITE(6,999)                                                             756
      WRITE(6,132) ITC                                                         758
      ITS = ITC/100                                                            759
      WRITE(6,999)                                                             761
      WRITE(6,133) ITS                                                         765
      ITD= ITS*9                                                               766
      WRITE(6,134) ITD                                                         767
      WRITE(6,999)                                                             768
C                                                                              769
C                                                                              770
C  20S.W.G. FLAGSPAN ALUMINIUM                                                 772
      CALL ZPGNG(22)                                                           773
      WRITE(6,224)                                                             774
  224 FORMAT(////11X,87H20S.W.G. FLAGSPAN ALUMINIUM 10/3 PITCH CIRCULAR P      775
     1ROFILE ROOF SHEETING FIXED TO HARDWOOD/16X,55HPORTION WITH GALV.         776
     2MILD STEEL DRIVE SCREWS AND WASHERS)                                     777
      WRITE(6,113)                                                             778
      WRITE(6,226)                                                             779
  226 FORMAT(1H ,15X,74HASSUME 10FT. LONG SHEETS NET WIDTH = 27":AREA CO       780
     1VERED PER SHEET = 22SQ.FT.)                                              781
      READ(1,5233)IPF                                                          782
 5233 FORMAT(I5)                                                               783
      WRITE(6,227)IPF                                                          785
  227 FORMAT(1H ,15X,27HCOST ON SITE PER LINEAR FT.,58X,I4)                    787
      WRITE(6,999)                                                             788
      ITF = IPF*10                                                             789
      WRITE(6,228)ITF                                                          791
  228 FORMAT(1H ,15X,14HCOST PER SHEET,71X,I4)                                 792
      IPF = (ITF*100)/22                                                       793
      WRITE(6,132) IPF                                                         794
      WRITE(6,212)ICW                                                          796
      WRITE(6,47)                                                              797
      WRITE(6,123)ICL                                                          798
      WRITE(6,4002)ICLB,ICLR                                                   799
      ITO =0.05*(ICL +ICLR)                                                    801
```

```
      WRITE(6,[illegible]
      ICG= ITO+ ICL +ICLB                                                    794
      WRITE(6,10)ICG                                                  795
      IOH = (ICG+3)/8                                                        797
      WRITE(6,236)IOH                                                        798
  236 FORMAT(1H ,15X,24HOUTPUT 100SQ.FT. IN 3HRS,61X,I4)                     799
      IGP = 0.25*(IOH +ISW + IHF )                                           780
      WRITE(6,26) IGP                                                        781
      IGP=IGP+IOH +ISW + IHF                                                 783
      WRITE(6,999)
      WRITE(6,132) IGP                                                       784
      ISP = IGP/100                                                          786
      WRITE(6,999)
      WRITE(6,133) ISP                                                       787
      ISD = ISP *9                                                           789
      WRITE(6,999)
      WRITE(6,134) ISD                                                       790
      WRITE(6,999)
C
C
C  0.5" CEMENT AND SAND
      CALL ZPGNG(26)                                                  793R
      WRITE(6,241)                                                           793
  241 FORMAT(//11X,55HCEMENT AND SAND(1:3)RENDER ON CONCRETE BLOCK WALLS 794R
     1 1/2",38X,1HK)                                                    795R
      WRITE(6,242)                                                           796
  242 FORMAT(1H ,15X,19HCOST OF MORTAR(1:3))                                 797
      ICSD = ICS* 0.33                                                       798
      WRITE(6,244)ICSD                                                       799
  243 FORMAT(1H ,15X,15HCEMENT 0.33TONS,70X,I4)                       800
      ICS=ICS*1.04                                                           801
      WRITE(6,244)ICS                                                        802
  244 FORMAT(1H ,15X,14HSAND 1.04C.YD.,71X,I4)                        803
      ITO =0.05*(IOS+ICSD)                                                   804
      WRITE(6,90) ITO                                                 805
      WRITE(6,159)IMM                                                        807
      IPM=IMM +ITO +IOS +ICSD                                                808
      WRITE(6,91) IPM                                                        809
      ITP= IPM/27                                                            811
      WRITE(6,161) ITP                                                       812
      WRITE(6,117)                                                           814
      IQM=ITP+4.17                                                           816
      WRITE(6,250)IQM                                                        817
  250 FORMAT(1H ,15X,38HQUANTITY OF MORTAR REQD.100*1/24 =4.17,47X,I4)   818
      ITO =0.10*IQM                                                          819
      WRITE(6,251)ITO                                                        820
  251 FORMAT(1H ,15X,21HAPPLICATION WASTE 10%,64X,I4)                 821
      WRITE(6,47)                                                            822
      ICLP= ICLB*1                                                           824
      WRITE(6,4004)ICLB,ICLP                                          825
      ICL = 2*ICLA                                                           827
      NON=2                                                           829
      WRITE(6,4007)NON,ICLA,ICL                                       830
      IOT = 0.05*(ICL+ICLP)                                           831
      WRITE(6,4031)IOT                                                832
      ICG = IOT + ICL + ICLP                                                 833
      WRITE(6,10)ICG                                                  834
      WRITE(6,252)                                                           836
  252 FORMAT(1H ,15X,25HOUTPUT 20 SQ. FT. PER DAY)                           837
```

```
C
      943         THP=(TCC*100)/200                                                 R38
      944         WRITE(6,132) THP                                                   39
      945         ISA=50                                                            R41
C     946         WRITE(6,259)ISA                                                   R42
      947     259 FORMAT(1H ,15X,16HALLOW FOR SCREWS,69X,I4)                        R43
      948         IGP =0.25*(ISA+THP +IOM + ITO)                                        R44
C     949         WRITE(6,26) IGP                                                       R45
      950         ISH=IGP+ISA+IWP+IOM+ITO                                           R47
      951         WRITE(6,999)
      952         WRITE(6,132) ISH                                                      R48
      953         ISF =ISH/100                                                          R50
      954         WRITE(6,999)
      955         WRITE(6,133) ISF                                                      R51
      956         ISD = ISF + 9                                                         R53
      957         WRITE(6,999)
      958         WRITE(6,134) ISD                                                      R54
      959 C
      960 C
      961 C  TYROLEON RENDER
      962         CALL ZPENG(30)                                                    R55
      963         WRITE(6,264)                                                          R56
      964     264 FORMAT(//11X,51HTYROLEON RENDER ON CONCRETE BLOCK WALLS  EXTERNALL R57
     1Y)                                                                            R58
      966         WRITE(6,265)                                                          R59
      967     265 FORMAT(1H ,15X,15HTAKE 30 SQ.YDS.)                                R60
      968         WRITE(6,266)                                                          R61
      969     266 FORMAT(1H ,15X,35HRENDERING COAT CEMENT AND SAND(1:6))            R62
      970         WRITE(6,267)                                                          R63
      971     267 FORMAT(1H ,15X,57HQUANTITY OF MATERIALS REQUIRED,270*0.625/12 = 14    R64
     1.06 C.FT.)                                                                    R65
      973         WRITE(6,91)IPV                                                    R66
      974         IPF  = IPV/27                                                     R68
      975         ICM = IPF * 14.06                                                 R67
      976         WRITE(6,268)ICM                                                       R68
      977     268 FORMAT(1H ,15X,29HCOST OF MATERIALS 14.06 C.FT.,,56X,I4)          R69
      978         IAW = 0.10 * ICM                                                      R70
      979         WRITE(6,251) IAW                                                      R71
      980         IS = 80                                                               R73
      981         WRITE(6,270)IS                                                        R74
      982     270 FORMAT(1H ,15X,13HSCREEDS ALLOW,,2X,I4)                           R75
      983         WRITE(6,47)                                                           R76
      984         WRITE(6,193)ICC                                                   R78
      985         WRITE(6,272)                                                          R79
      986     272 FORMAT(1H ,15X,28HOUTPUT 30 SQ.YDS IN 1.5 DAYS)                   R80
      987         ICL=ICC * 1.5                                                     R81
      988         WRITE(6,273)ICL                                                       R82
      989     273 FORMAT(1H ,15X,14HCOST OF LABOUR,71X,I4)                          R83
      990         ITR=ICL+ISH+IAW+ICM                                               R84
      991         WRITE(6,274)ITR                                                       R85
      992     274 FORMAT(1H ,15X,24HTOTAL FOR RENDERING COAT,61X,I4)                R86
      993         WRITE(6,275)                                                          R87
      994     275 FORMAT(1H ,15X,14HFINISHING COAT)                                 R88
      995         WRITE(6,276)                                                          R89
      996     276 FORMAT(1H ,15X,32HMATERIALS REQUIRED FOR 30 SQ.YDS)               R90
      997         WRITE(6,83)ICW                                                    R91
      998         ISD = ISC * 1.375                                                 R93
      999         WRITE(6,277) ISC,ISD                                              R94
     1000     277 FORMAT(16X,18H1.375 C.YD. SAND @,I5,1HK,60X,I5)                   R95
     1001         ISP = 0.05 * (ICW + ISD)                                          R96
```

```
      WRITE(6,900) ISP                                                  899
      WRITE(6,159)IMM                                                   899
      IAW = 0.10 * (IMM + ISP + ICH + ISD)                              900
      WRITE(6,251) IAW                                                  901
      WRITE(6,477                                                       903
      WRITE(6,10)ICG                                                    905
      WRITE(6,281)                                                      906
  281 FORMAT(1H ,15X,25HOUTPUT 30 SQ.YDS IN 6 HRS)                      907
      ICL = ICG * 6/8                                                   908
      WRITE(6,282)ICL                                                   909
  282 FORMAT(1H ,15X,14HCOST OF LABOUR,71X,I4)                          910
      ITF = ICL + IAW + IMM + ISP + ICH + ISD                           911
      WRITE(6,283)ITF                                                   912
  283 FORMAT(1H ,15X,24HTOTAL FOR FINISHING COAT,61X,I4)                913
      IGP = 0.25 *(ITF + ITR)                                           914
      WRITE(6,26) IGP                                                   915
      ITD = IGP + ITF + ITR                                             917
      WRITE(6,285)ITD                                                   918
  285 FORMAT(1H ,15X,14HPER 30 SQ YDS.,71X,I4)                          919
      ISD = ITD/30                                                      920
      WRITE(6,999)
      WRITE(6,13) ISD                                                   921
      WRITE(6,999)
C
C
C
      CALL ZPGNG(22)                                                    923
      WRITE(6,287)                                                      923
  287 FORMAT(///11X,8HN1.25 CEMENT AND SAND (1:4) FLOORING LAID IN ONE C 924
     1OAT AND TROWELLED SMOOTH ON CONC. BED,7X,1HK)                     925
      WRITE(6,81)ICS                                                    926
      ICT = ICS * 0.30                                                  927
      WRITE(6,288)ICT                                                   928
  288 FORMAT(1H ,15X,16HCEMENT 0.30 TONS,69X,I4)                        929
      IOS = ISC * 1.12                                                  931
      WRITE(6,290) ISC,IOS                                              932
  290 FORMAT(16X,17H1.12 C.YD. SAND @,I5,1HK,61X,I5)                    933
      ISP = 0.05 * (IOS + ICT)                                          934
      WRITE(6,905) ISP                                                  935
      WRITE(6,159)IMM                                                   937
      IPC = ISP + IMM + IOS + ICT                                       938
      WRITE(6,91) IPC                                                   939
      IPF = IPC/27                                                      941
      WRITE(6,161) IPF                                                  942
      WRITE(6,117)                                                      944
      ICK=IPF*10.4                                                      945
      WRITE(6,295)ICK                                                   946
  295 FORMAT(1H ,15X,55HQUANTITY OF MORTAR REQUIRED = 100*1.25/12 = 10.4 947
     113 C.FT.,30X,I2)                                                  948
      IPA=0.10*ICK                                                      949
      WRITE(6,251) IPA                                                  950
      IS = 50                                                           951
      WRITE(6,298)IS                                                    953
  298 FORMAT(1H ,15X,17HALLOW FOR SCRAPS,68X,I4)                        954
      WRITE(6,477)                                                      955
      WRITE(6,193)ICC                                                   957
      WRITE(6,300)                                                      958
  300 FORMAT(1H ,15X,26HOUTPUT 200 SQ.FT PER DAY)                       959
      ICC = ICG * 100/200                                               960
```

```
      WRITE(6,172) TCC                                                  961
      IGP=0.25*(TCC+TS+TPA+TCK)                                         963
      WRITE(6,26)IGP
      TCH=IGP+TCC+TS+TPA+TCK                                            966
      WRITE(6,132) TCH                                                  967
      TCF = TCH/100                                                     969
      WRITE(6,999)
      WRITE(6,133) TCF                                                  970
      TCD = TCF * 9                                                     972
      WRITE(6,999)
      WRITE(6,134) TCD                                                  973
      WRITE(6,999)
C
C
C  6" BY 6" WHITE GLAZED WALL
      CALL ZPGNG(21)                                                974
      WRITE(6,306)                                                      975
  306 FORMAT(///11X,'6"*6" WHITE GLAZED WALL TILING FIXED WITH ADHESIV 976
     1E ON SCREEDED BACKING MEASURED SEPARATELY)                        977
      WRITE(6,182)                                                      978
      READ(1,5235)IQT                                                   980
 5235 FORMAT(I5)                                                        981
      WRITE(6,308)IQT                                                   982
  308 FORMAT(1H ,15X,30HCOST OF TILES PER 100 O/D SITE,55X,I4)          983
      WRITE(6,999)                                                      9838
      WRITE(6,309)                                                      984
  309 FORMAT(1H ,15X,47HQUANTITY OF TILES REQUIRED = 10/(0.5 * 0.5)= 40)    985
      ICT = 1400*40/100                                                 986
      WRITE(6,310)ICT                                                   987
  310 FORMAT(1H ,15X,27HCOST OF TILES PER 10 SQ.FT.,,58X,I4)            988
      IW = 0.10 * ICT                                                   990
      WRITE(6,182) IW                                                   991
      READ(1,5236)ICA                                                   992
 5236 FORMAT(I5)                                                        993
      WRITE(6,312)ICA                                                   994
  312 FORMAT(1H ,15X,55HCOST OF ADHENSIVE COVERING CAPACITY 128 SQ.FT. P    995
     1ER GAL.,,30X,I7)                                                  996
      WRITE(6,999)                                                      9968
      IDA = ICA * 10/128                                                997
      WRITE(6,313)IDA                                                   998
  313 FORMAT(1H ,15X,30HCOST OF ADHESIVE PER 10 SQ.FT.,,55X,I4)         999
      IPW = 0.10 * IDA                                                  1000
      WRITE(6,314)IPW                                                   1001
  314 FORMAT(1H ,15X,18HRESIDUAL WASTE 10%,67X,I4)                      1002
      ICL = ICLR *2/8                                                   1003
      WRITE(6,315)ICL                                                   1004
  315 FORMAT(1H ,15X,17H1 PLASTERER 2 HRS,68X,I4)                       1005
      ICLT = ICLA *2 *2 /8                                              1006
      WRITE(6,316)ICLT                                                  1007
  316 FORMAT(1H ,15X,17H2 LABOURERS 2 HRS,68X,I4)                       1008
      ITO = 0.05 *(ICL + ICLT)                                          1009
      WRITE(6,317)ITO                                                   1010
  317 FORMAT(1H ,15X,12H5% FOR TOOLS,73X,I4)                            1011
      IGP = 0.25 *(ITO + ICL + ICLT + IPW + IDA + IW +ICT)              1012
      WRITE(6,26) IGP                                                   1013
      IPP = IGP + ITO + ICL + ICLT + IPW +IDA + IW +ICT                 1015
      WRITE(6,196) IPP                                                  1016
      IPS = IPP/10                                                      1018
      WRITE(6,999)
```

```
                      WRITE(6,999)                                                  10438
                      IP= IPU + 5                                                   10444
                      WRITE(6,742)IP                                                10445
      732 FORMAT(1H ,15V,10HS LR PUTTY,75X,14)                                      1044
                      WRITE(6,473)
                      IGL = ICLR + 1                                                1049
                      WRITE(6,4083)ICL,IGL                                          1050
                      ITO = 0.05 * IGL                                              1052
                      WRITE(6,4041)ITO                                              1053
                      WRITE(6,723)                                                  1055
      732 FORMAT(1H ,15V,24HOUTPUT 20 SQ.FT. PER DAY)                               1056
                      ICL = (IGL +1TO)/20 + 10                                      1057
                      WRITE(6,733)ICL                                               1058
      733 FORMAT(1H ,15V,28HCOST OF LABOUR FOR 10 SQ.FT.,57X,I4)                    1059
                      IGP= 0.25 * (ICL + IP + IU + ISG )                            1060
                      WRITE(6,24) IGP                                               1061
                      IPG=(IGP + ICL+ IP + IW + ISG )                               1063
                      WRITE(6,106) IPG                                              1064
                      IPS = IPG/10                                                  1066
                      WRITE(6,999)
                      WRITE(6,123) IPS                                              1067
                      WRITE(6,999)
                      WRITE(6,999)
C
C     PREPARATION AND APPLICATION OF PAINTS                                         1070
                      CALL ZPAINT(IO)
                      WRITE(6,732)                                                  1071
      737 FORMAT(///1X,10HPREPARE AND APPLY TWO COATS EMULSION PAINT ON PEN1072     1073
                      IOFFD WALLS)                                                  1078
                      WRITE(6,999)
                      IPE= IPU + 5                                                  1044
                      WRITE(6,724)IP                                                1045
      728 FORMAT(1H ,15V,10HS LR PUTTY,75X,14)                                      1046
                      WRITE(6,473)
                      IGL = ICLR + 1                                                1049
                      WRITE(6,4083)ICL,IGL                                          1050
                      ITO = 0.05 * IGL                                              1052
                      WRITE(6,4041)ITO                                              1053
                      WRITE(6,723)                                                  1055
      732 FORMAT(1H ,15V,24HOUTPUT 20 SQ.FT. PER DAY)                               1056
                      ICL = (IGL +1TO)/20 + 10                                      1057
                      WRITE(6,733)ICL                                               1058
      733 FORMAT(1H ,15V,28HCOST OF LABOUR FOR 10 SQ.FT.,57X,I4)                    1059
                      IGP= 0.25 * (ICL + IP + IU + ISG )                            1060
                      WRITE(6,24) IGP                                               1061
                      IPG=(IGP + ICL+ IP + IW + ISG )                               1063
                      WRITE(6,106) IPG                                              1064
                      IPS = IPG/10                                                  1066
                      WRITE(6,123) IPS                                              1067
                      WRITE(6,999)
                      WRITE(6,999)
C
C     PREPARATION AND APPLICATION OF PAINTS                                         1074
                      CALL ZPAINT(IO)                                               1070
                      WRITE(6,732)                                                  1071
      737 FORMAT(///1X,10HPREPARE AND APPLY TWO COATS EMULSION PAINT ON PEN1072     1073
                      IOFFD WALLS)                                                  1078
                      WRITE(6,999)
                      IPV = IPS + 9                                                 1021
                      WRITE(6,116) IPV                                              1022
                      WRITE(6,999)
C
C     240Z CLEAR SHEET GLASS                                                        1025
                      CALL ZPAINT(IO)
                      WRITE(6,723)                                                  1026
      722 FORMAT(///1X,54H24 OZ CLEAR SHEET GLASS AND GLAZING TO METAL WITH1027
                     1PUTTY,30X,1HX )                                               1028
                      WRITE(6,783)
                      READ(1,5713)IA
                      WRITE(6,5737)
      5737 FORMAT(15)                                                               1032
                      WRITE(6,724)IA                                                1033
      724 FORMAT(1H ,15V,15H10 SQ.FT. OF 24 OZ GLASS PER SQ.FT.,50X,I4)             1034
                      IGL = 10.0*IG                                                 1034B
                      WRITE(6,999)                                                  1034C
                      WRITE(6,4083)IGL                                              1034C
      402 FORMAT(1H ,15V,27HCOST OF 10 SQ. FT. OF GLASS, 58X,I4)                    1054E
                      IGL = IG * 0.15 + IPG                                         1055
                      WRITE(6,753)IA                                                1056
      375 FORMAT(1H ,15V,9HVASIT 15X,76X,I4)                                        1057
                      WRITE(6,736)IA                                                1058
      376 FORMAT(1H ,15V,25HPUTTY ALLOW 1/4 IN /SQ.FT)                              1059
                      READ(1,5213)IAD                                               1060
      5278 FORMAT(15)                                                               1061
                      WRITE(6,727)IAD                                               1062
      727 FORMAT(1H ,15V,12HPUTTY PER LR,75X,I4)                                    1063
                      WRITE(6,999)
                      IPE= IPU + 5                                                  1044
                      WRITE(6,724)IP                                                1045
      728 FORMAT(1H ,15V,10HS LR PUTTY,75X,14)                                      1046
                      WRITE(6,473)
                      IGL = ICLR + 1                                                1049
                      WRITE(6,4083)ICL,IGL                                          1050
                      ITO = 0.05 * IGL                                              1052
                      WRITE(6,4041)ITO                                              1053
                      WRITE(6,723)                                                  1055
      732 FORMAT(1H ,15V,24HOUTPUT 20 SQ.FT. PER DAY)                               1056
                      ICL = (IGL +1TO)/20 + 10                                      1057
                      WRITE(6,733)ICL                                               1058
      733 FORMAT(1H ,15V,28HCOST OF LABOUR FOR 10 SQ.FT.,57X,I4)                    1059
                      IGP= 0.25 * (ICL + IP + IU + ISG )                            1060
                      WRITE(6,24) IGP                                               1061
                      IPG=(IGP + ICL+ IP + IW + ISG )                               1063
                      WRITE(6,106) IPG                                              1064
                      IPS = IPG/10                                                  1066
                      WRITE(6,123) IPS                                              1067
                      WRITE(6,999)
                      WRITE(6,999)
C
C     PREPARATION AND APPLICATION OF PAINTS                                         1074
                      CALL ZPAINT(IO)                                               1070
                      WRITE(6,732)                                                  1071
      737 FORMAT(///1X,10HPREPARE AND APPLY TWO COATS EMULSION PAINT ON PEN1072     1073
                      IOFFD WALLS)                                                  1078
```

```
      WRITE(6,338)
  338 FORMAT(1H ,15X,15HTAKE 100 SQ.YDS)
      WRITE(6,339)
  339 FORMAT(1H ,15X,64HCOVERING  CAPACITY OF EMULSION PAINT FIRST COAT 5
     1O SQ.YDS PER GAL/16X,82HSECOND COAT 60 SQ.YDS PER GALL. QUANTITY R
     2EQUIRED : FIRST COAT 100/50 = 2.00 GALS /16X,61HSECOND COAT 100/60
     3= 1.67 GALS : 3.67 GALS)
      READ(1,5240)IEP
 5240 FORMAT(I5)
      WRITE(6,340)IEP
  340 FORMAT(1H ,15X,22HEMULSION PAINT PER GAL,63X,I4)
      WRITE(6,999)
      IPE = IEP * 3.67
      WRITE(6,341)IPE
  341 FORMAT(1H ,15X,24H3.67 GALS EMULSION PAINT,61X,I4)
      IAR = 0.15 * IPE
      WRITE(6,342)IAR
  342 FORMAT(1H ,15X,34HAPPLICATION AND RESIDUAL WASTE 15%,51X,I4)
      WRITE(6,47)
      IPH=IPE + 0.04
      WRITE(6,344)IPH
  344 FORMAT(1H ,15X,11HBRUSH HAND,,24X,I4)
      ITO = 0.05 * IPH
      WRITE(6,345)ITO
  345 FORMAT(1H ,15X,12H5% FOR TOOLS,71X,I4)
      WRITE(6,346)
  346 FORMAT(1H ,15X,24HOUTPUT 40 SQ.YDS PER DAY)
      IOP =(IPH + ITO)*100/40
      WRITE(6,132) IOP
      ICP  = 0.25 *(IOP +IAR +IPE)
      WRITE(6,24) ICP
      IPO = ICP + IOP + IAR + IPE
      WRITE(6,349)IPO
  349 FORMAT(1H ,15X,15HPER 100 SQ.YDS,,70X,I4)
      IPO = IPO/100
      WRITE(6,999)
      WRITE(6,136) IPO
      WRITE(6,999)
C
C
C  5"*2" HARDWOOD DOOR FRAMES
      CALL ZPGNG(25)
      WRITE(6,505)
  505 FORMAT(///11X,64HCONSTRUCTION OF HARDWOOD DOOR-FRAMES JOINERY  CO
     1NSISTING 12"0"*20X,1HX)
      READ(1,5242)IHES,IDWP,ICWT, TIMEJ,IPTF,IDST,INLS, TIMET
 5242 FORMAT(I5/I5/I5/F5.1/I5/I5/I5/F5.1)
      ICJON = IRTF + TIMEJ
      WRITE(6,506)IHES,IDWP,ICWT, TIMEJ,IRTF,ICJON,IDST
  506 FORMAT(1H ,15X,31HCOST OF 5"*2" HARDWOOD EX-STOCK,53X,I5/
     11H ,15X,30HALLOW FOR DELIVERY TO WORKSHOP,54X,I5/
     11H ,15X,38HALLOW FOR CONVERTING TO WROUGHT TIMBER,46X,I5/
     11H ,15X,F5.1,15HHRS JOINERY @  ,F5.88 PER HR,51X,I5/
     1 26HALLOW FOR DELIVERY AT SITE,58X,I5)
      ICOST1= IHES + IDWP + ICWT + ICJON + IDST
      WRITE(6,999)
      WRITE(6,502)ICOST1
  502 FORMAT(1H ,99X,I5)
      INCT = INLS/4
```

```
      508 FORMAT(1H ,15X,26HALLOW FOR 1/4 LB NAILS @  ,I5,8HK PER LB,45X,I5)
          IWASTE = (ICOST1 + INCT )*10 / 100
          WRITE(6,251)IWASTE
          ICOST2= ICOST1 + INCT + IWASTE
          WRITE(6,999)
          WRITE(6,509)ICOST2
      509 FORMAT(1H ,99X,I5)
          WRITE(6,47)
          WRITE(6,510) TIMET
      510 FORMAT(1H ,15X,38HTRADESMAN TAKING DELIVERY AND FIXING--,F5.1,19H
         1HRS FOR DOOR FRAME/1H ,15X,35HASSUME LENGTH OF AVERAGE DOOR 16'0")
          IFD = TIMET * IRTE
          IFD = IFD + 12 / 16
          WRITE(6,511) TIMET,IRTE,IFD
      511 FORMAT(1H ,15X,22HCOST FOR 12' 0"=12/16*,F5.1,1H*,I5,51X,I5)
          IGP = (ICOST2 + IFD) / 4
          WRITE(6,24) IGP
          WRITE(6,999)
          ICOST3 = ICOST2 + IFD + IGP
          WRITE(6,512) ICOST3
      512 FORMAT(1H ,15X,15HCOST FOR 12' 0",69X,I5)
          IPF = ICOST3 / 12
          WRITE(6,999)
          WRITE(6,513) IPF
      513 FORMAT(1H ,15X,13HCOST PER FOOT,71X,I5)
          WRITE(6,999)
C
C
C  6"*2"      HARDWOOD PURLINS
          CALL ZPANS(22)
          WRITE(6,514)
      514 FORMAT(///11X,48HHARDWOOD PURLINS - CARPENTRY - CONSIDERING 12'0",
         145X,1H*)
          READ(1,5244)IWES,IDST,IUNL,INLS,IOUT
     5244 FORMAT(I5/I5/I5/I5/I5)
          INCT=INLS/15
          WRITE(6,517)IWES,IDST,IUNL,INLS,INCT
      517 FORMAT(1H ,15X,31HCOST OF 6"*2" HARDWOOD EX-STOCK,53X,I5/
         1H ,15X,26HALLOW FOR DELIVERY TO SITE,58X,I5/
         1H ,15X,27HTAKING DELIVERY & UNLOADING,57X,I5/
         1H ,15X,25HALLOW FOR NAILS 1/15 LB @,I5,8HK PER LB,46X,I5)
          WRITE(6,999)
          ICOST1= IWES + IDST + IUNL + INCT
          WRITE(6,518)ICOST1
      518 FORMAT(1H ,99X,I5)
          IWASTE= ICOST1 * 10/100
          WRITE(6,251)IWASTE
          WRITE(6,999)
          ICOST2= ICOST1 + IWASTE
          WRITE(6,519)ICOST2
      519 FORMAT(1H,99X,I5)
          WRITE(6,47)
          WRITE(6,520)IOUT
      520 FORMAT(1H ,15X,11HOUTPUT    =,I5,14H  CU FT PER HR)
          IFD= 6 * 12 * IOUT * IRTE / (144 * 2)
          WRITE(6,521)IFD
      521 FORMAT(1H ,15X,24HCOST FOR 12' 0" OF 6"*2",60X,I5)
          IGP= (ICOST2 + IFD)/4
```

```
      WRITE(6,20)IGP
      ICOST3= ICOST2 + IFD + IGP
      WRITE(6,999)
      WRITE(6,522)ICOST3
  522 FORMAT(1H ,15X,15HCOST FOR 12' 0",69X,I5)
      IPF= ICOST3/12
      WRITE(6,999)
      WRITE(6,523)IPF
  523 FORMAT(1H ,15 X,10HRATE PR FT,74X,I5)
      WRITE(6,999)
      STOP
 4000 FORMAT(20X,14H1 HEAD-MAN   @,I5,1HK,50X,I5)
 4001 FORMAT(20X,14H1 MASON      @,I5,1HK,30X,I5)
 4002 FORMAT(20X,14H1 CARPENTER  @,I5,1HK,30X,I5)
 4003 FORMAT(20X,14H2 MASONS     @,I5,1HK,30X,I5)
 4004 FORMAT(20X,14H1 PLASTERER  @,I5,1HK,30X,I5)
 4005 FORMAT(20X,14H1 GLAZIER    @,I5,1HK,30X,I5)
 4006 FORMAT(20X,14H1 LABOURER   @,I5,1HK,30X,I5)
 4007 FORMAT(20X,I2,12H LABOURERS @,I5,1HK,30X,I5)
 4010 FORMAT(20X,I5)
 4011 FORMAT(20X,9HTOOLS  5%,41X,I5)
      END
      SHORTLIST
      SUBROUTINE ZPGIT
      INTEGER ZPGLN,ZPGNO,ZPGMX
      COMMON/ZPGCM/ZPGLN,ZPGNO,ZPGMX,ZPGDT,ZPGTT(10)
      CALL DATE(ZPGDT)
      ZPGNO=0
      READ(1,10)ZPGTT
   10 FORMAT(10A8)
      ZPGMX=58
      CALL ZPGTP
      RETURN
      END
      SUBROUTINE ZPGTP
      INTEGER ZPGLN,ZPGNO,ZPGMX
      COMMON/ZPGCM/ZPGLN,ZPGNO,ZPGMX,ZPGDT,ZPGTT(10)
      ZPGNO=ZPGNO+1
      WRITE(2,10) ZPGTT,ZPGDT,ZPGNO
   10 FORMAT(1H1,15X,10A8,1X,A8,6H PAGE ,I4/)
      ZPGLN=0
      RETURN
      END
      SUBROUTINE ZPGBT
      INTEGER ZPGLN,ZPGNO,ZPGMX
      COMMON/ZPGCM/ZPGLN,ZPGNO,ZPGMX,ZPGDT,ZPGTT(10)
      WRITE(2,30)
   30 FORMAT(1H2,90X,23HCOMPUTER CENTRE, A.B.U.)
      RETURN
      END
      SUBROUTINE ZPGNU
      INTEGER ZPGLN,ZPGNO,ZPGMX
      COMMON/ZPGCM/ZPGLN,ZPGNO,ZPGMX,ZPGDT,ZPGTT(10)
      CALL ZPGBT
      CALL ZPGTP
      RETURN
      END
      SUBROUTINE ZPGNG(ZPGLS)
      INTEGER ZPGLS
```

```
1356           INTEGER ZPGLN,ZPGNO,ZPGMX
1357           COMMON/ZPGCM/ZPGLN,ZPGNO,ZPGMX,ZPGDT,ZPGTT(10)
1358           ZPGLN=ZPGLN+ZPGIS
1359           IF(ZPGMX-ZPGLN) 10,20,20
1360     10    CALL ZPGRT
1361           CALL ZPGTP
1362           ZPGLN=ZPGIS
1363     20    RETURN
1364           END
1365           FINISH
```

User's Guide for Programme QS01

1. Control Cards (15)

a) Heading Cards

2 - 72 (ZPGIT) - title card for programme identification.

2 - 72 (ZPGNG(20)) - Heading Card.

b) Control data Card (15)

IBS - Basic Cost per labourer

PID - Provident Fund

IPS - Sick Pay

IHS - Hospital Visits

ITS - Government Training Scheme

IAH - Annual Holidays allow

IR - Rains Allow

IPH - Public Holidays

ICA - Leave Allowance per annum

ICL - Cost per labourer per 8-hour day

2. Materials Property Cards.

a) Unit Conversion Card (15), (16).

a) Excavate Oversite (15)

ICLB - Headman

NLAB - Labourers

ICLA - Masons

ILD - Labourers and Masons

ITA - Wastes

ICG - Gang and Waste

ICY - Cost per Cubic Yard

IPS - Cost per Square Yard of excavation 6" thick.