NATIONAL BUREAU OF STANDARDS REPORT

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LIVE LOAD STUDIES OF CONVEYOR SYSTEMS AND POSTAL FACILITIES

Interim Report

for: Post Office Department

NBS

U.S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

NATIONAL BUREAU OF STANDARDS

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[3] Located at 5285 Port Royal Road, Springfield, Virginia 22151.

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by

J. O. Bryson
and
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1. Introduction

The postal facility at Greensboro, N. C. was selected as the first of 9 mail handling facilities to be surveyed in connection with the program "Live Load Studies of Conveyor Systems and Postal Facilities." This is a broad program for an investigation of the existing loads on a representative sample of mail-handling facilities located across the nation. The program is planned to develop comprehensive information on the magnitude and distribution of actual loads imposed on facilities as the basis for engineering recommendations concerning the appropriate structural live loads to be used in the design of future postal facilities. Also, loads and forces related to conveyor systems will be measured and evaluated.

The initial phase of the work was devoted to studies of POD Engineering Design Standards and drawings, meetings and discussions with POD officials and mechanization contractors, and field visits to selected facilities for on-site orientation. The purpose of the work in this phase was to develop a sufficient background of information on mail handling operations, process machinery, and facility layouts, to formulate the most suitable measurement techniques and evaluative methods for conducting the study. Concurrently, load sensing devices and data acquisition instrumentation for field measurements were being designed and developed in the laboratory.

The information obtained from the preliminary studies suggested that the number of stories in a mail handling facility is an important denominator for live load evaluation. Consequently, a schedule of survey work which includes site visits to 9 postal facilities was prepared. The 9 facilities were selected from a list of 15 facilities[1/] originally suggested by POD for survey consideration. The 9 facilities that were chosen will provide a sample for facilities ranging in height from

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[1/] P. O. Project 68257, Work Assignment I.

1 to 4 stories and are grouped according to their number of stories to accommodate the work of field surveying, data reduction and evaluation, and reporting.

The facilities selected for load surveying are listed below.

Group	Facility	Number of Stories
I	Greensboro, N. C.	1
	Chicago (AMF), Ill.	1
	Buffalo, N. Y.	1
II	Los Angeles (AMF), Calif.	2
	Houston, Texas	2
	New Orleans, La.	2
III	Omaha, Neb.	3
	Hartford, Conn.	3
	Detroit, Mich.	4

The principal criteria for selecting a facility were: (1) amount of mechanization equipment; (2) age of structure; and (3) location of facility. The aim was to study the loads in highly mechanized facilities of modern construction and where possible, in those representing different regions of the country.

2. General Approach

2.1 Loads Imposed on the Structures

2.1.1 Definitions

The loads that are being investigated in this study are the occupancy loads imposed on the structure. They are defined as follows:

(1) Mail load - all types of mail in various containers being processed or stored within the facility.

(2) Fixed mechanization load - load due to the weight of mail processing equipment either anchored to the ceiling or bolted to the floor (i.e., storage conveyors, parcel and sack sorting machines, letter sorting machines, etc.)

(3) Mobile mail handling and miscellaneous operating equipment - items that are used to contain the mail that is being processed or stored on the work floor, also including different types of maintenance equipment (i.e., baskets, hand trucks, tables, bag

racks, motorized sweepers, etc.)

(4) People - the weight of the maximum number of people assigned to a specific area.

These loads are ordered into two groups according to the manner in which they are supported by the structure. They are ceiling supported loads and floor supported loads as follows:

I. Ceiling Loads

1) Fixed mechanization (ceiling suspended conveyors)

2) Mail

II. Floor Loads

1) Fixed mechanization (floor mounted conveyors) and workroom equipment.

2) Mobile mail handling and miscellaneous operating equipment.

3) Mail

4) People

Obviously, in a multi-story facility consideration must be given to the combined effect of the ceiling loads of one story and the floor loads of the story above it.

2.2 Survey Techniques and Procedures

2.2.1 Ceiling-Suspended Conveyor Dead Loads

In order to investigate the extent to which the dead weight of overhead mechanization contributes to ceiling-suspended loads, sections of conveyor systems were selected for examination which were representative of ordinary and extraordinary mechanization construction. These selected sections were chosen with particular regard to their weight based on the apparent degree of complexity of construction. Such choices included locations of change of direction in conveyor systems, junctions, crossovers, slides, sack sorting systems, etc. These sample sections were chosen and examined at the facility site. For the mechanization within the area (in plan view) occupied by a selected section, field tabulations were made of measurements of the quantities of structural and other materials forming that section of the system. Sizes of members were measured wherever possible; inaccessible portions were estimated visually and checked against engineering drawings when necessary. These field data were later converted to weights by use of established tabular unit weight values. Further reduction and evaluation of the data are discussed in Section 2.3.1.

2.2.2 Mail Loads on Conveyors

Automated conveyor systems facilitate the handling and processing of bulk mail. There are two main types of conveyors corresponding to the two principal functions of the system. They are, (1) transport conveyors and (2) storage conveyors. The transport conveyors normally operate continuously at a constant speed and are intended to move incoming and outgoing sacks or parcels to and from facility processing locations. Mail load density on transport conveyors is affected by rate of loading. Storage conveyors normally operate intermittently by being jogged forward only when triggered by an oncoming sack (or parcel) and provide temporary self-accommodating storage of mail awaiting processing. In contrast with a transport conveyor which carries mail separated by spaces of various lengths along its belt, a storage conveyor belt is loaded solidly, virtually without spaces along its length. In either case the progressively variable loading condition makes it desirable to know the location and magnitude of the mail load in measuring total conveyor loads.

A measurement technique was devised which made it possible to conveniently determine the mail load on a conveyor at any instant of time under a constantly changing state of loading.

In order to circumvent the use of a massive amount of instrumentation that would be required for a direct measurement of the magnitude and distribution of loads on conveyors, the technique devised takes advantage of particular features of large bulk mail conveyors. These conveyors have a transporting surface, which is a continuous belt supported by rollers spaced along the length of the conveyor. Since the belt is flexible and does not produce moment transfer at the supports, the system acts as a series of hinged spans. Therefore, the influence line for a roller reaction from the mail load being transported along the belt can be indicated by an analog trace of the reaction force which varies with the movement of the load on the belt. This means that by instrumenting a belt support roller to continuously measure and record the magnitude of the loads coming onto the roller and to correspondingly record the movement of the loads with respect to the roller, information is developed to determine the amount and spacing of the loads for any partial or full length of conveyor.

Figure 1 shows a calibrated load sensing "weigh-plate" installed on one end of a roller. Two weigh-plates, one on each end of a roller, were used to measure the load.

The output signal from the two load transducers (connected in parallel) was fed to the recording oscillograph shown in Figure 2. Concurrently with the analog load trace there was also recorded an accompanying "parallel" belt-travel trace which contained pulses that indicated the passage of a 2-ft. length of conveyor belt (the common spacing between load supporting rollers). These pulses were triggered by an idler wheel arrangement shown in Figure 3. The idler wheel was mounted in rolling contact with the continuous conveyor belt at a convenient location and had a circumference equal to the 2-ft. center line spacing of the load rollers. A button-like tripper on one face of the wheel depressed a micro-switch arm at each revolution and triggered a low voltage signal which was recorded as the trace spike. The spacing of the spikes on the oscillogram was representative of the load-roller spacing on the conveyor.

The instrumentation technique employed provided data for determining mail loads over various lengths of a conveyor, in particular: (1) lengths of conveyor mail load which contribute to the load on a suspension hanger; and (2) total conveyor lengths of mail load for correlation with associated electric drive motor current.

For comparison with the calculated hanger loads mentioned in (1) above, independent measurements were made of the live load force in a hanger by means of a small tubular load cell (containing electric resistance strain gages) shown in Figure 4. This tubular load transducer was fitted over a selected hanger rod between its conveyor-supporting cross-bar and bottom retaining nut. Such an arrangement detected the load in one of a pair of hangers intended to support a standard section length (10 ft.) of conveyor. The output signal from this load cell was also recorded by the oscillograph.

Measurements of electric current drawn by the conveyor drive motor were made using an ammeter. A clamp-on type ammeter was placed on one of the three lead wires of the drive motor to measure its current. Figure 5 shows a view of the ammeter installed in a conveyor control panel. The current measurement was fed to the oscillograph as a calibrated signal and recorded as a continuous trace concurrently with the others.

Further interrelationship and correlation of the oscillogram traces are described under 2.3.2 Note: A fifth signal trace (generated by a clock motor) was recorded to indicate beginnings and ends of the automatically controlled

recording periods (15 min. per hour). The circuitry was designed so that the oscillograph would operate at those times that the conveyor belt was moving during the 15 minute sampling periods. An override switch permitted recording for longer periods when desired. In either case, however, the oscillograph recorded only when the conveyor belt was moving. Thus, the weigh-plate trace, was a continuous record of the load passing over the instrumented roller even though the belt might have stopped temporarily.

2.2.3 Floor Loads

The structural loads imposed on the work floor are directly associated with floor processing activities and the equipment used in carrying out and supporting the activities. The mail processing activities on the floor are carried out in an essentially open bay floor area lined with regularly spaced structural columns. The floor is divided into designated work areas of different sizes, depending on activities, usually covering a number of bays.

Survey techniques and procedures were devised to obtain and record the weights and approximate horizontal locations of all items on the workfloor areas. Floor plans of the building were used to note work area layouts and locations.

A further breakdown of the floor area was made by defining the areas bounded by column lines as grid squares. The grid squares were then divided into 1/2-span mid-strips and 1/4-span column-strips corresponding to the structural strips considered in bending moment design of a two-way flat slab. The overlapping of the strips in the two directions formed a pattern of grid area sectors which provided a general location scheme (see Figure 6). In cases where the boundary of a work area did not coincide with a column line, the work area then contained partial grid squares.

During the planning stage for the floor loads survey work a reference catalog was prepared which describes items of mail handling equipment and furniture normally used in mail processing operations. Each catalog entry included a color photograph of the item, an assigned numerical code, dimensions, composition, empty weight and other pertinent descriptive information.

The determination of the loads in the survey involved either direct weighing of items or estimation of the weights. An estimate of the weight for any item is based on the known empty weight plus an estimate of the amount of content in the item. Contents were categorized as (1)

letters, (2) flats and circulars, or (3) parcels. These contents were estimated either in terms of percent of capacity or in terms of linear feet of content. Specific items had previously been load-calibrated for 100 percent capacity or for weight per unit length. Very helpful information and data on mail weights were provided by post office officials at the facilities visited.

The floor loads data were coded and logged on forms in a format suitable for direct transcription onto computer cards for automatic data processing.

2.3 Data Reduction and Evaluation

The first level reduction of the loads data collected in this study is designed to provide a broad description of the characteristics of the loads as related to either conveyors or work floor areas. The type of reduction that the data receives has to do with the type of loading that it represents. For fixed nonvarying loads (i.e. weight of suspended conveyors) a rather simple process of data reduction for obtaining discrete load-area relationships is sufficient. For the varying load of bulk mail acting on a conveyor the data is reduced to give information on the magnitudes and variations in distributed loadings over various lengths of

the conveyor and for the forces induced in the conveyor suspension rods. The reduction of this type of data is directed toward determining the loading spectrum for the resolution of the mean and upper limit extreme values and the relationship between the two. The most involved reductions are for the data from the floor load survey where information on the loading spectrum related to several different elements of the floor area is the first level objective.

2.3.1 Ceiling Suspended Conveyor Dead Loads

The field data for suspended mechanization loads were recorded in the form of dimensions and types of construction materials for selected sections of conveyors and other processing machinery. The area occupied by a mechanization section and its location within the plan of the building were also recorded. These data were reduced to total weights of sections located within specific horizontal areas. Calculations were made to determine values for the total load equally distributed over the horizontal area for each mechanization section. In addition, the hanger loads for conveyor suspension rods were calculated for two different support arrangements: (1) with suspension rods located at the four corners for small conveyor sections; (2) with suspension

rods supporting large conveyor sections every 5 ft. in a rectangular coordinate grid. The four corner support calculations were made for conveyor sections with areas of 75 sq. ft. of less (the smallest section examined was 5 ft. by 5 ft. = 25 sq. ft.). The 5 ft. rectangular grid support points were choosen since they conform to the POD specification for the arrangement of insert anchor points for the support of suspended mechanization systems.

2.3.2 Mail Loads on Conveyors

The field data pertaining to conveyor mail loads consists of an oscillogram record containing 5 traces described in Section 2.2.2: (1) instrumented roller load trace; (2) belt travel trace (i.e., 2-ft. interval marker); (3) drive motor current trace; (4) hanger load-cell trace; and (5) recording period end point marker trace. It might be noted that the amount of data (i.e., the physical length of the oscillogram) varied from one observation period (15 min. each hour) to the next, depending on the total time of belt movement which occurred during the 15 minutes.

For simplicity, the length of a conveyor and other length dimensions along it, determined in the field, were referred to in terms of load roller intervals (i.e., 2-ft. intervals).

Infrequent departures from this standard roller spacing in a conveyor were disregarded, and the conveyor was considered to have as many 2-ft. intervals as its measured length (rounded to the nearest 2 ft.) divided by 2.

Mail loads over a given length of belt can be determined by summing scaled values from the weigh-plate load trace opposite the appropriate number of pulses (spikes) on the belt travel trace. A knowledge of certain other length dimensions, made possible some additional correlations between the oscillogram data. They were the distances from the beginning of the conveyor to the instrumented roller and to the hanger load cell. The distance between these two locations and the "purge" length were also known. The "purge" length was the length of a conveyor belt beyond the instrumented roller to the end of the conveyor which had to be cleared of unrecorded mail load at the beginning of a recording period before known, full-length belt loads could be determined. The location of the 2-ft. interval marker wheel was unrelated but remained fixed, once established. Knowing these dimensions made possible a comparison between recorded hanger loads and the associated lengths of belt load which were recorded through the weigh-plates at a different point in time. Also, it was possible to correlate the maximum and minimum currents

observed during a recorded interval (i.e., belt travel of 2 ft.) with the total mail load on the conveyor at that time; this included instances of belt starting and stopping.

Data from the oscillogram were translated to digital form and were processed by a computer program written to provide the information described below. Operations were performed on the data within one recording period and/or groups of periods.

(1) As a first examination of how mail loads passing through a 10-ft. section of a long conveyor might vary, a tabulation (Table 2) was made of sums of 5 consecutive weigh-plate readings, shifting the grouping of 5 interval values from beginning to end of the listed data by an increment of 1 interval. This was equivalent to observing the loads on a 10-ft section changing as the mail passed through, 2 ft. at a time. The values presented in this table are pounds of load and are in order by rows starting at the top of the page and reading from left to right.

(2) These above values of 5-interval sums were reduced to values of Uniformly Distributed

Load in lb/sq. ft. (over occupied belt area) and printed out as a frequency distribution (Figure 8) along with its statistical characteristics such as mean value, standard deviation, etc.

(3) To determine the effect of length of belt load on average and maximum values of loading, basic statistical characteristics for loadings over different lengths of the conveyor belt were computed (see Table 3). The statistical properties determined were: (1) maximum value; (2) specified tolerance limits (for confidence in the distribution); (3) mean value; (4) standard deviation. These properties were determined for loadings on belt lengths ranging from 10 consecutive intervals (representing 20 ft) and increasing by 5 interval steps (10 ft) up to the nearest length greater than the overall belt length. The values computed are in psf.

(4) The data presented in Table 3 are shown plotted in Figure 9. This plot shows the mean and plus and minus one standard deviation for samples of loadings on different lengths of the conveyor. The load properties are plotted

on the vertical axis against conveyor belt length in 2 ft intervals on the horizontal axis.

(5) A frequency distribution was plotted for theoretically calculated loads which occurred in a single hanger rod of pairs of rods spaced at 10 ft. along the conveyor (Figure 10). This calculation was also a summing-shifting operation through the weigh-plate load data but took into account the proportionate influence of loads at different distances within 10 ft. to either side of a hanger. The frequency is shown on the vertical scale with hanger loads on the horizontal scale.

(6) A plot was made of various total belt loads vs. associated drive motor currents (Figure 11). Again a summing-shifting operation was employed to obtain the full-length belt load existing at the time of the recording interval of the two associated current values. However, these related load-current readings were correlated only for every 10th interval of observation.

(7) A frequency distribution was plotted for maximum measured hanger load occurring in an obervation period (Figure 12).

(8) A comparison was plotted of the above maximum measured hanger loads vs. calculated hanger loads computed from the appropriate weigh-plate values (Figure 13).

2.3.3 Floor Loads

A computer program has been prepared for evaluating the data to provide meaningful information on the loads related to work activity and the geometry of the structure. The following is a list of the principal output of the computer program for a preliminary analysis of the data:

(1) Table of the total loads on the floor uniformly distributed over the floor area for each floor level.

(2) Values of the uniformly distributed loads for each work area.

(3) Table of the uniformly distributed loads for each grid square.

(4) Table of the percentage of occupied space for work areas.

(5) A plot of cumulative fractions of loaded area supporting discrete loads equal to or greater than a specific value.

(6) Frequency distribution of uniformly distributed loads for all grid squares giving basic statistical characteristics for the distribution.

(7) Frequency distributions of the uniformly distributed loads for grid square sectors with basic statistical information.

(8) Frequency distribution of the occupied space in grid squares as a percentage of grid square area.

3. Preliminary Results of Loads Study at Greensboro, North Carolina

The Greensboro Post Office facility is a one-story structure for mail handling operations with approximately 98,000 sq. ft. of workroom floor area. It is a highly mechanized modern facility with a network of roof-suspended mechanization equipment covering a large portion of the ceiling area. Figure 14 is a photograph of the facility showing a view as seen by the general public with the office wing of the complex dominating the picture. The plain surface wall extending to the right of the office wing encloses the mail processing portion of the facility. Also, a portion of a platform area for unloading mail can

be seen to the left of the office wing. Figure 15 shows the plan view of the building with the workroom area indicated; the labeling of the co-ordinate column grid square system is shown in Figure 16. This floor is divided into specific work areas as shown in Figure 17. The work areas outlined are those defined by officials at the facility. Figure 18 shows the plan view of the fixed mechanization equipment for sack sorting, parcel sorting, and bulk conveyors.

3.1 Ceiling-Suspended Conveyor Dead Loads

Table 1 presents values of uniformly distributed and concentrated loads caused by conveyors and their structural support, calculated as described in Section 2.3.1 and located as shown in Figure 7. At a given location (encircled on the floor plan) the labeled overall section referred to is marked by heavy straight lines bounding the conveyor system. This area was further subdivided for more specific consideration of included loads. The subscript letters of area designations refer to cardinal directions, (F_W=F, Westerly).

In area A (Figure 7), the easterly portion A_E contains a crossover area involving twelve conveyors, TSS-1 thru 5,

SS-1 thru 6, and S-5. The sub-areas A_1 thru A_6 in A_W are each structurally supported take-up roller areas for their respective conveyors SS-1 thru 6.

In area B, B_N contains conveyor SP-1 and its traveling deflector; area B_S contains the tail ends of conveyors SPS-1 thru 5. A slide area between areas B_N and B_S is totally supported between them and its weight is so apportioned. The following areas are conveyor corners or junctions and contain conventional conveyor, support, walk, and mechanical construction for the indicated conveyors:

Area	Conveyors
C	S-5 to SS-7
D	S-6 to S-7
E	S-3 to S-4
F	S-9 to SS-8
G	RRD-9 to RRD-10

Area H contains a typical section of a 4-track over-under carrousel parcel sorter PSM-1 thru 4, together with tail ends of conveyors T-6 and 7. Area K contains a typical section of a 2-track over-under carrousel sack sorter SSM-1 and 2, together with tail ends of conveyors SD-7 and CSS-1. It is to be noted that values for uniformly distributed loads (UDL) were computed for dead weights of mechanization sections alone (UDL_1) and for mechanization sections with

design live load added on to the conveyor belt areas where they would occur (UDL_2). The design live loads (mail) used are those currently specified by POD. The computed hanger rod loads for the 5 ft-spaced coordinate grid support points is based on one suspension rod supporting that portion of the total load which is uniformly distributed over 25 sq. ft.

3.2 Mail Loads on Conveyors

The conveyor chosen for observation of conveyor mail loads at Greensboro, N. C., was SS-7. Its length for load calculation purposes was taken as 91 2-ft. intervals (actual length, 182 1/2 ft); its cross section is 36" high by 42" wide. It operates at one speed of approximately 2 1/2 ft./sec. either continuously for transport or intermittently for storage, and is driven by a motor rated at 5 H.P., wired for 480 volts, 6.4 amps, 3 ph. To illustrate the results, the largest and most representative sample of heavy mail load on the conveyor was selected as examples. The processing of the data was carried out with a computer program and the results are shown by the following computer print-outs.

1. Table 2 is a tabulation of 443 sums of strings of 5 consecutive weigh-plate readings obtained

from 447 individual consecutive scaled values (not shown). Note the occasional occurrence of stretches of empty belt during continuous operation.

2. Figure 8 is the frequency distribution for the values of Table 2 reduced to lb./sq. ft. The data of the illustrations are among the higher intensities of loading encountered so far in the reduction of Greensboro data.

3. Table 3 lists the data used in plotting Figure 9 for investigating at what length of belt examination the determination of loading characteristics appears to stabilize.

4. Figure 10 is a frequency distribution of calculated hanger loads with consideration given to the proportionate influence of roller loads (as measured by the weigh-plates) within 10 ft. (5 intervals) to either side of the hanger.

5. Figure 11 is a plot correlating full length belt loads (which may include empty stretches) with the amount of current being drawn. The plot is for every 10th interval of belt travel. For each interval observed the

maximum and minimum currents were plotted for a common belt load value. A slight trend of increase in current with increase in load is detectable with greater variation noted at higher loads.

6. Figure 12 is a frequency plot of maximum load-cell-measured hanger load per period for 11 periods.
7. Figure 13 is a comparison of maximum observed hanger loads (Figure 12) with the associated theoretical loads (Section 2.3.2, item 8). It should be noted that the reaction force in the observed hanger rod was influenced by the loading and supporting conditions of nearby conveyor sections. Further consideration will be given to the correlation of these values.

Most of the computer graphical displays and tabulations can and will be applied to multiple period groupings as data are accumulated, such processing being limited only by the computer memory capacity.

3.3 Floor Loads

The floor load results are presented in the form of computer output which is the first level reduction and evaluation of

the data. The computer prints out tables and graphs of principal output information and data relationships. Only a part of the output is presented here as examples of the results since the program is still in the debugging stage with a few output errors to be corrected.

Table 4 gives the percentage of space occupied by the items encountered in each work area and for the total building (workroom). The work area codes correspond to the designations shown in Figure 17. Note that the floor area occupied by all of the mail handling and processing items on the work floor (Bldg. T.) is about 1/5 of the sum of the work areas. Not included in this fraction are the people and a few specific fixtures. The floor space occupied by load items within designated work areas varies from about 18 percent for work area 6, to 31 percent for work area 10. Table 5 lists all of the grid squares or partial grid squares having uniformly distributed loads of 10 lb./sq. ft. or more. Fifteen grid areas out of a total of 85 surveyed contained loads greater than 10 lb./sq. ft.[2/] The grid square with

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2/At the Greensboro facility, a grid square defined by the building column lines had dimensions of 33 ft. by 33 ft. and contained 1089 sq. ft.

the heaviest uniformly distributed load was C10 with 16 lb./sq. ft. Table 6 lists the grid sectors[3/] supporting loads of 50 lb./sq. ft. or more. Only three were found. Figure 6 shows grid sectors and their identification codes layed out in relation to a grid square.

Figure 19 is a histogram for the frequency distribution of uniformly distributed loads for all grid squares in the survey. Statistical computations of the distribution give a mean of 6.7 lb./sq. ft., standard deviation of 3.1, and tolerance limits for 75 percent of the data with a 90 percent probability of from 2.9 psf to 11.0 psf.

Figure 20 shows the frequency distribution of the percentage of grid square area occupied by the load items.

An important factor in the study of floor loads is the relationship between floor area and loading. Figure 21 shows a plot of work area vs. uniformly distributed load for all work areas.

There were many different types of load items encountered in the survey, and they varied widely in weight and in

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3/See Section 2.2.3, page 12 for definition.

size. The weight of a given item divided by the floor area that it occupies is defined as its discrete unit load. It follows that items of different weight may produce the same discrete load on the floor depending on the respective item size. The sum of the floor area occupied by load items is defined as the loaded area. Figures 22 through 32 show the relationship between loaded area and discrete load values for each of the work areas and for the combined areas in the survey. The area supporting discrete loads greater than a specific value is given as a ratio of the total loaded area on the vertical axis and the values of discrete load are given along the horizontal axis. Therefore, these plots indicate the fraction of the loaded area which supports loads greater than a particular value of discrete load. For example, it is seen in Figure 22 that 40 percent of the loaded area in work area 1 supports loads greater than 30 lb./sq. ft. and the largest discrete load in this area is 90 lb./sq. ft. on about 2 percent of the loaded area (note that the ratio of loaded area to total area is given on the plot).

4. List of Tables and Figures

Tables

Figures

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Fig. 26 - Plot of cumulative fractions of loaded area carrying loads greater than a discrete value for work area 5.

Fig. 27 - Plot of cumulative fractions of loaded area carrying loads greater than a discrete value for work area 6.

Fig. 28 - Plot of cumulative fractions of loaded area carrying loads greater than a discrete value for work area 7.

Fig. 29 - Plot cumculative fractions of loaded area carrying loads greater than a discrete value for work area 8.

Fig. 30 - Plot of cumulative fractions of loaded area carring loads greater than a discrete value for work area 9.

Fig. 31 - Plot of cumulative fractions of loaded area carrying loads greater than a discrete value for work area 10.

Fig. 32 - Plot of cumulative fractions of loaded area carrying loads greater than a discrete value for total workroom area.

USCOMM-NBS-DC

Mechanization Section	Total Material Weight (lb)	Plan Area of Section (sq. ft.)	Gross* UDL. W/O L.L. (PSF)	Gross UDL2 Incl. Conveyor L.L. @30 PSF (PSF)	Hanger Load, Assuming 4 - Corner Support		Hanger Load, Assuming Support at 5 Ft. Co-ord Grid Pts.	
					W/O L.L. (lb/hanger)	with conveyor L.L. @30 PSF (lb/hanger)	W/O L.L. (lb/hanger)	with conveyor L.L. @30 PSF (lb/hanger)
A	68,000	1780	38	67	-	-	880	1560
A_w	40,400	990	41	64	-	-	820	1280
A_e	27,600	790	35	73	-	-	790	1640
A1→6	3,750	32	117	142	940	1150	-	-
B	21,000	590	36	51	-	-	750	1070
B_s	12,100	240	50	72	-	-	670	970
B_n	8,900	200	44	62	-	-	560	780
C_s	3,300	25	130	150	820	950	-	-
C_n	2,700	35	80	100	680	870	-	-
D_w	3,300	35	95	116	830	1010	-	-
D_e	3,500	30	150	170	1110	1270	-	-
E	5,800	120	50	65	-	-	580	860
E_n	1,400	30	47	68	350	510	-	-
E_e	3,300	60	54	75	830	1130	-	-
E_s	1,100	30	38	-	280	-	-	-
F	6,500	110	59	75	-	-	650	820
F_w	2,300	35	66	87	580	750	-	-
F_e	2,700	35	77	98	670	850	-	-
G_w	1,800	25	73	90	460	560	-	-
G_e	1,300	25	54	70	340	430	-	-
H	16,600	360	46	61	-	-	690	920
K	11,400	140	80	88	-	-	950	1040

*UDL = Uniformly Distributed Load; L.L. = Mail Live Load

TABLE 1 - TABLE OF CEILING LOADS CALCULATED FROM ESTIMATED DEAD WEIGHT IN SELECTED SECTIONS OF MECHANIZATION.

SUMS OF STRINGS OF 5 CONSECUTIVE READINGS (PERIOD 2)

45.000	23.000	5.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	9.000	17.000	28.000	39.000	39.000	30.000	22.000
34.000	29.000	29.000	29.000	29.000	6.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	13.000	17.000	17.000	17.000	17.000
4.000	.000	.000	5.000	34.000	34.000	34.000	34.000	29.000	.000
.000	.000	.000	.000	.000	12.000	17.000	17.000	17.000	17.000
5.000	.000	.000	.000	.000	4.000	8.000	8.000	8.000	8.000
4.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	4.000	17.000	17.000	17.000
17.000	25.000	27.000	33.000	33.000	44.000	49.000	34.000	28.000	51.000
105.000	121.000	121.000	140.000	172.000	122.000	89.000	89.000	78.000	33.000
37.000	80.000	122.000	120.000	147.000	154.000	163.000	201.000	236.000	253.000
254.000	225.000	176.000	150.000	115.000	159.000	165.000	197.000	269.000	308.000
278.000	256.000	226.000	284.000	255.000	278.000	284.000	319.000	186.000	201.000
189.000	223.000	197.000	218.000	231.000	271.000	265.000	284.000	327.000	341.000
276.000	261.000	200.000	124.000	68.000	170.000	180.000	198.000	237.000	241.000
112.000	76.000	58.000	26.000	45.000	45.000	45.000	45.000	38.000	4.000
61.000	76.000	91.000	103.000	142.000	119.000	111.000	134.000	127.000	94.000
101.000	105.000	105.000	100.000	130.000	112.000	117.000	79.000	95.000	84.000
61.000	50.000	100.000	96.000	67.000	125.000	165.000	171.000	178.000	178.000
120.000	130.000	108.000	146.000	170.000	184.000	129.000	95.000	49.000	25.000
15.000	44.000	114.000	127.000	133.000	129.000	119.000	54.000	52.000	68.000
68.000	49.000	44.000	22.000	.000	.000	.000	23.000	27.000	33.000
53.000	59.000	111.000	136.000	194.000	259.000	264.000	189.000	209.000	193.000
165.000	199.000	239.000	239.000	232.000	175.000	145.000	127.000	137.000	108.000
126.000	138.000	121.000	92.000	126.000	152.000	141.000	185.000	188.000	178.000
134.000	128.000	146.000	201.000	217.000	266.000	293.000	282.000	231.000	269.000
253.000	274.000	233.000	246.000	193.000	160.000	119.000	159.000	169.000	162.000
241.000	289.000	300.000	249.000	253.000	201.000	136.000	70.000	65.000	63.000
87.000	147.000	176.000	184.000	177.000	151.000	155.000	157.000	207.000	193.000
246.000	244.000	314.000	292.000	328.000	273.000	211.000	110.000	77.000	56.000
51.000	107.000	113.000	118.000	195.000	215.000	188.000	235.000	255.000	162.000
135.000	182.000	226.000	220.000	263.000	294.000	218.000	190.000	174.000	121.000
124.000	210.000	167.000	260.000	350.000	317.000	231.000	259.000	248.000	239.000
329.000	412.000	418.000	386.000	334.000	289.000	211.000	151.000	108.000	123.000
132.000	172.000	243.000	323.000	387.000	405.000	384.000	318.000	245.000	152.000
142.000	196.000	249.000	258.000	288.000	299.000	251.000	200.000	240.000	239.000
196.000	175.000	195.000	188.000	167.000	204.000	233.000	274.000	239.000	228.000
186.000	163.000	119.000	115.000	126.000	114.000	163.000	189.000	221.000	205.000
184.000	120.000	88.000	105.000	154.000	199.000	290.000	302.000	237.000	196.000
155.000	68.000	38.000	27.000	81.000	100.000	100.000	118.000	154.000	136.000
166.000	250.000	259.000	245.000	257.000	240.000	193.000	203.000	181.000	148.000
118.000	97.000	110.000	173.000	192.000	212.000	279.000	284.000	227.000	182.000
156.000	73.000	22.000							

TABLE 2 - SUMS OF STRINGS OF 5 CONSECUTIVE WEIGH-PLATE READINGS.

```
SUMS OF STRINGS OF   10 CONSECUTIVE READINGS     (PERIOD   2)
SAMPLE SIZE IS   438           MAXIMUM VALUE IS     9.671
TOLERANCE LIMITS (    .00,   7.94)  FOR COVERAGE= .90, PROBABILITY= .90
STANDARD DEVIATION=   2.6      MEAN=    3.8

SUMS OF STRINGS OF   15 CONSECUTIVE READINGS     (PERIOD   2)
SAMPLE SIZE IS   433           MAXIMUM VALUE IS     8.905
TOLERANCE LIMITS (    .05,   7.62)  FOR COVERAGE= .90, PROBABILITY= .90
STANDARD DEVIATION=   2.5      MEAN=    3.8

SUMS OF STRINGS OF   20 CONSECUTIVE READINGS     (PERIOD   2)
SAMPLE SIZE IS   428           MAXIMUM VALUE IS     8.421
TOLERANCE LIMITS (    .06,   7.46)  FOR COVERAGE= .90, PROBABILITY= .90
STANDARD DEVIATION=   2.4      MEAN=    3.8

SUMS OF STRINGS OF   25 CONSECUTIVE READINGS     (PERIOD   2)
SAMPLE SIZE IS   423           MAXIMUM VALUE IS     8.411
TOLERANCE LIMITS (    .07,   7.34)  FOR COVERAGE= .90, PROBABILITY= .90
STANDARD DEVIATION=   2.4      MEAN=    3.8

SUMS OF STRINGS OF   30 CONSECUTIVE READINGS     (PERIOD   2)
SAMPLE SIZE IS   418           MAXIMUM VALUE IS     7.600
TOLERANCE LIMITS (    .12,   7.25)  FOR COVERAGE= .90, PROBABILITY= .90
STANDARD DEVIATION=   2.3      MEAN=    3.8

SUMS OF STRINGS OF   35 CONSECUTIVE READINGS     (PERIOD   2)
SAMPLE SIZE IS   413           MAXIMUM VALUE IS     7.808
TOLERANCE LIMITS (    .10,   7.13)  FOR COVERAGE= .90, PROBABILITY= .90
STANDARD DEVIATION=   2.3      MEAN=    3.8

SUMS OF STRINGS OF   40 CONSECUTIVE READINGS     (PERIOD   2)
SAMPLE SIZE IS   408           MAXIMUM VALUE IS     7.543
TOLERANCE LIMITS (    .09,   7.13)  FOR COVERAGE= .90, PROBABILITY= .90
STANDARD DEVIATION=   2.2      MEAN=    3.9

SUMS OF STRINGS OF   45 CONSECUTIVE READINGS     (PERIOD   2)
SAMPLE SIZE IS   403           MAXIMUM VALUE IS     7.400
TOLERANCE LIMITS (    .18,   7.05)  FOR COVERAGE= .90, PROBABILITY= .90
STANDARD DEVIATION=   2.2      MEAN=    3.9

SUMS OF STRINGS OF   50 CONSECUTIVE READINGS     (PERIOD   2)
SAMPLE SIZE IS   398           MAXIMUM VALUE IS     7.220
TOLERANCE LIMITS (    .17,   6.94)  FOR COVERAGE= .90, PROBABILITY= .90
STANDARD DEVIATION=   2.2      MEAN=    3.9

SUMS OF STRINGS OF   55 CONSECUTIVE READINGS     (PERIOD   2)
SAMPLE SIZE IS   393           MAXIMUM VALUE IS     7.094
TOLERANCE LIMITS (    .20,   6.83)  FOR COVERAGE= .90, PROBABILITY= .90
STANDARD DEVIATION=   2.1      MEAN=    3.9

SUMS OF STRINGS OF   60 CONSECUTIVE READINGS     (PERIOD   2)
SAMPLE SIZE IS   388           MAXIMUM VALUE IS     6.945
TOLERANCE LIMITS (    .18,   6.74)  FOR COVERAGE= .90, PROBABILITY= .90
STANDARD DEVIATION=   2.1      MEAN=    3.9

SUMS OF STRINGS OF   65 CONSECUTIVE READINGS     (PERIOD   2)
```

TABLE 3 - STATISTICAL CHARACTERISTICS OF FREQUENCY DISTRIBUTION OF BELT LOADINGS IN LB./SQ. FT. BASED ON SUMS OF STRINGS OF 10, 15, ... TO 95 CONSECUTIVE WEIGH-PLATE READINGS.

```
SAMPLE SIZE IS   383          MAXIMUM VALUE IS     6.910
TOLERANCE LIMITS (    .20,   6.60)  FOR COVERAGE= .90, PROBABILITY= .90
STANDARD DEVIATION=   2.0     MEAN=   3.9

SUMS OF STRINGS OF   70 CONSECUTIVE READINGS     (PERIOD   2)
SAMPLE SIZE IS   378          MAXIMUM VALUE IS     6.667
TOLERANCE LIMITS (    .21,   6.54)  FOR COVERAGE= .90, PROBABILITY= .90
STANDARD DEVIATION=   2.0     MEAN=   4.0

SUMS OF STRINGS OF   75 CONSECUTIVE READINGS     (PERIOD   2)
SAMPLE SIZE IS   373          MAXIMUM VALUE IS     6.629
TOLERANCE LIMITS (    .24,   6.45)  FOR COVERAGE= .90, PROBABILITY= .90
STANDARD DEVIATION=   1.9     MEAN=   4.0

SUMS OF STRINGS OF   80 CONSECUTIVE READINGS     (PERIOD   2)
SAMPLE SIZE IS   368          MAXIMUM VALUE IS     6.539
TOLERANCE LIMITS (    .26,   6.41)  FOR COVERAGE= .90, PROBABILITY= .90
STANDARD DEVIATION=   1.9     MEAN=   4.0

SUMS OF STRINGS OF   85 CONSECUTIVE READINGS     (PERIOD   2)
SAMPLE SIZE IS   363          MAXIMUM VALUE IS     6.450
TOLERANCE LIMITS (    .24,   6.33)  FOR COVERAGE= .90, PROBABILITY= .90
STANDARD DEVIATION=   1.9     MEAN=   4.0

SUMS OF STRINGS OF   90 CONSECUTIVE READINGS     (PERIOD   2)
SAMPLE SIZE IS   358          MAXIMUM VALUE IS     6.384
TOLERANCE LIMITS (    .27,   6.25)  FOR COVERAGE= .90, PROBABILITY= .90
STANDARD DEVIATION=   1.8     MEAN=   4.0

SUMS OF STRINGS OF   95 CONSECUTIVE READINGS     (PERIOD   2)
SAMPLE SIZE IS   353          MAXIMUM VALUE IS     6.290
TOLERANCE LIMITS (    .29,   6.19)  FOR COVERAGE= .90, PROBABILITY= .90
STANDARD DEVIATION=   1.8     MEAN=   4.0
```

TABLE 3 CON'T. - STATISTICAL CHARACTERISTICS OF FREQUENCY DISTRIBUTION OF BELT LOADINGS IN LB/SQ. FT. BASED ON SUMS OF STRINGS OF 10, 15, ... TO 95 CONSECUTIVE WEIGH-PLATE READINGS.

WORK AREA	PERCENTAGE OF OCCUPIED SPACE	OCCUPIED AREA(SQ.FT.)	TOTAL AREA(SQ.FT.)
1	20.5	1740.9	8512.0
2	28.0	2069.6	7392.0
3	20.8	2249.1	10806.0
4	25.0	2326.1	9315.0
5	24.7	511.3	2069.0
6	17.8	2006.5	11298.0
7	25.1	3088.3	12306.0
8	22.1	1920.3	8671.0
9	19.9	2888.6	14535.0
10	30.9	509.8	1650.0
BDG.T.	22.3	19310.6	86554.0

TABLE 4 - PERCENTAGE OF OCCUPIED SPACE IN WORK AREAS.

GRIDS LOADED WITH 10.0 LB. OR MORE PER SQUARE FOOT OF AREA

GRID NO.	FLOOR	DISTRIBUTED LOAD	GRID AREA
C03	1.0	11.2	1089.0
D04	1.0	12.4	272.0
E01	1.0	10.3	1089.0
J05	1.0	11.0	1089.0
K05	1.0	10.8	1089.0
K03	1.0	10.4	1021.0
J10	1.0	10.5	1089.0
F08	1.0	12.2	1089.0
G08	1.0	10.5	1089.0
F10	1.0	12.4	1089.0
G10	1.0	11.3	1089.0
E08	1.0	11.2	1089.0
B07	1.0	10.2	1089.0
B08	1.0	10.9	1089.0
C10	1.0	15.9	1089.0

TABLE 5 - TABLE OF GRID-SQUARES LOADED WITH MORE THAN SELECTED MINIMUM UNIFORMLY DISTRIBUTED LOAD OF 10 LB./SQ. FT.

GRID SECTORS LOADED WITH 50.0 LBS. OR MORE PER SQUARE FOOT OF AREA

GRID SECTOR	GRID NO.	FLOOR	DISTRIBUTED LOAD	SECTOR AREA
23	C03	1.0	50.8	68.1
34	C03	1.0	51.3	68.1
34	K05	1.0	53.9	68.1

TABLE 6 - TABLE OF GRID-SQUARE SECTORS LOADED WITH MORE THAN SELECTED MINIMUM UNIFORMLY DISTRIBUTED LOAD OF 50 LB/SQ. FT.

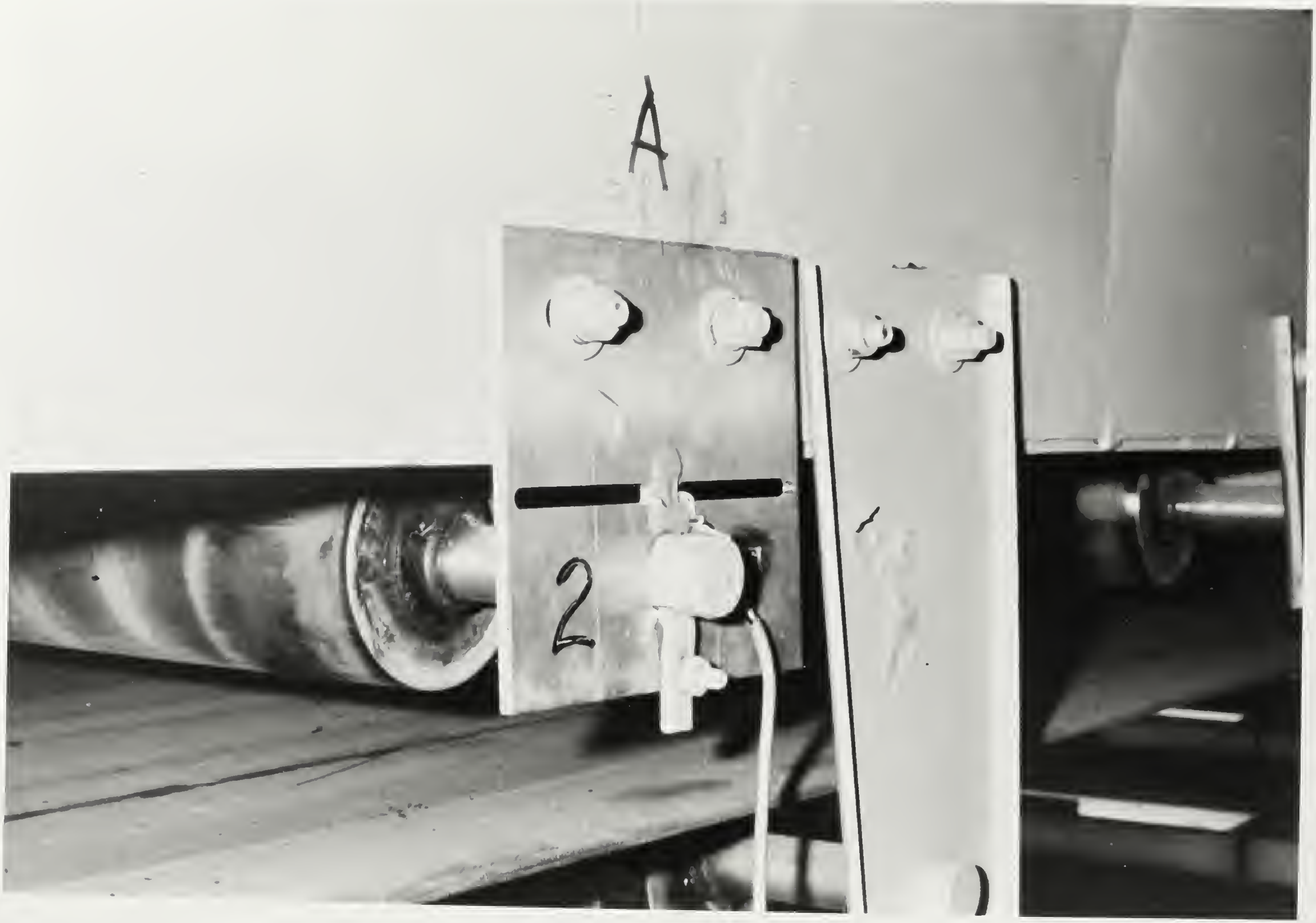


FIG. 1 - ONE END OF A CONVEYOR LOAD ROLLER WITH ONE OF TWO INSTRUMENTED WEIGH-PLATES (LOAD TRANSDUCERS) WHICH REPLACE STANDARD HANGER PLATES.

FIG. 2 - ELECTRONICS CONSOLE CONTAINING STRIP-CHART OSCILLOGRAPH AND RELATED EQUIPMENT FOR MEASURING OUTPUT FROM TRANSDUCERS INSTALLED ON CONVEYOR.

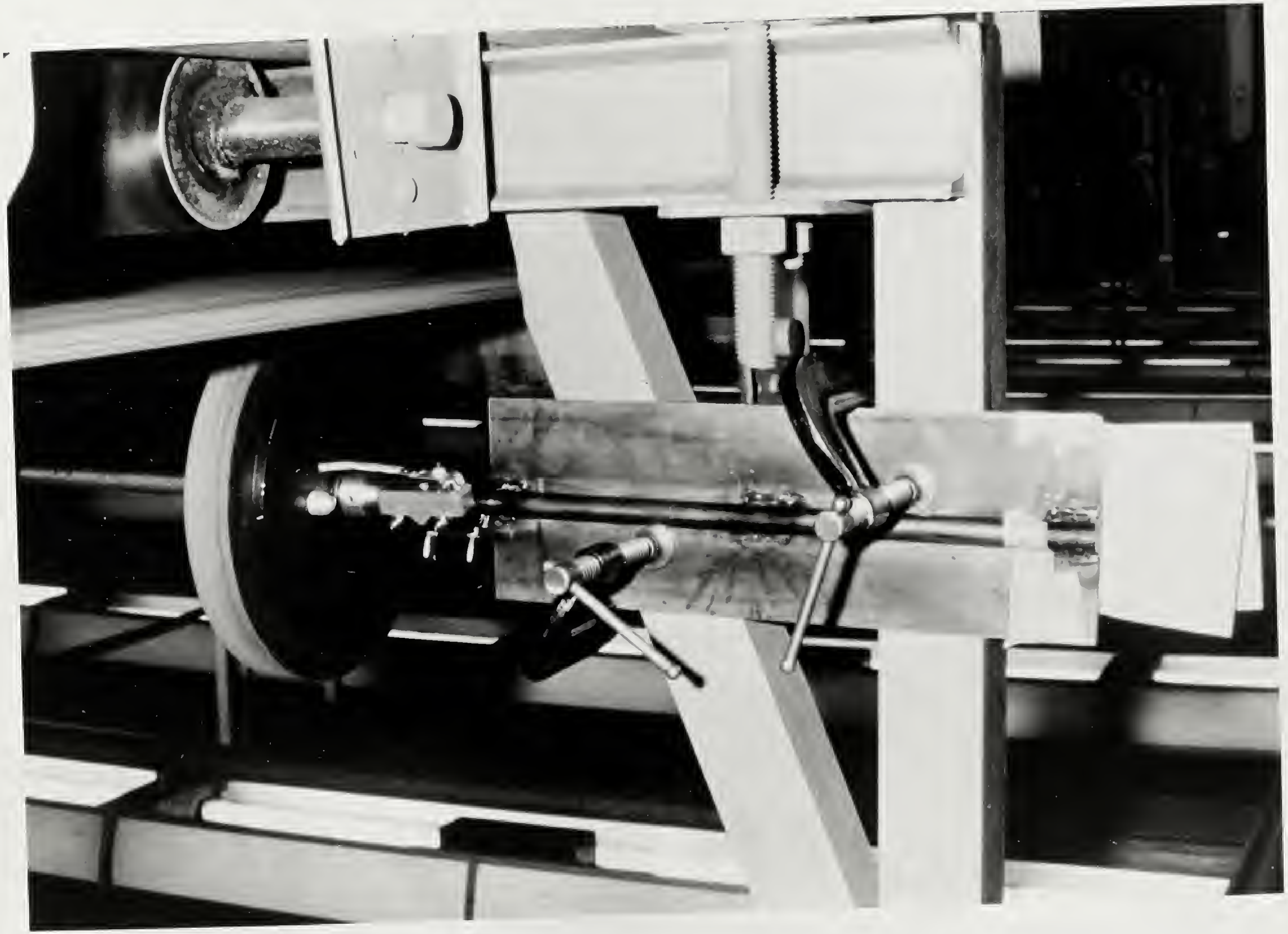


FIG. 3 - IDLER MARKING WHEEL IN ROLLING CONTACT WITH CONVEYOR BELT FOR REGISTERING PASSAGE OF 2-FT. INTERVALS OF BELT.

FIG. 4 - TUBULAR LOAD CELL SLIPPED ON OVER HANGER ROD BETWEEN CONVEYOR-SUPPORTING CROSS-BAR AND LOWER RETAINING NUT.

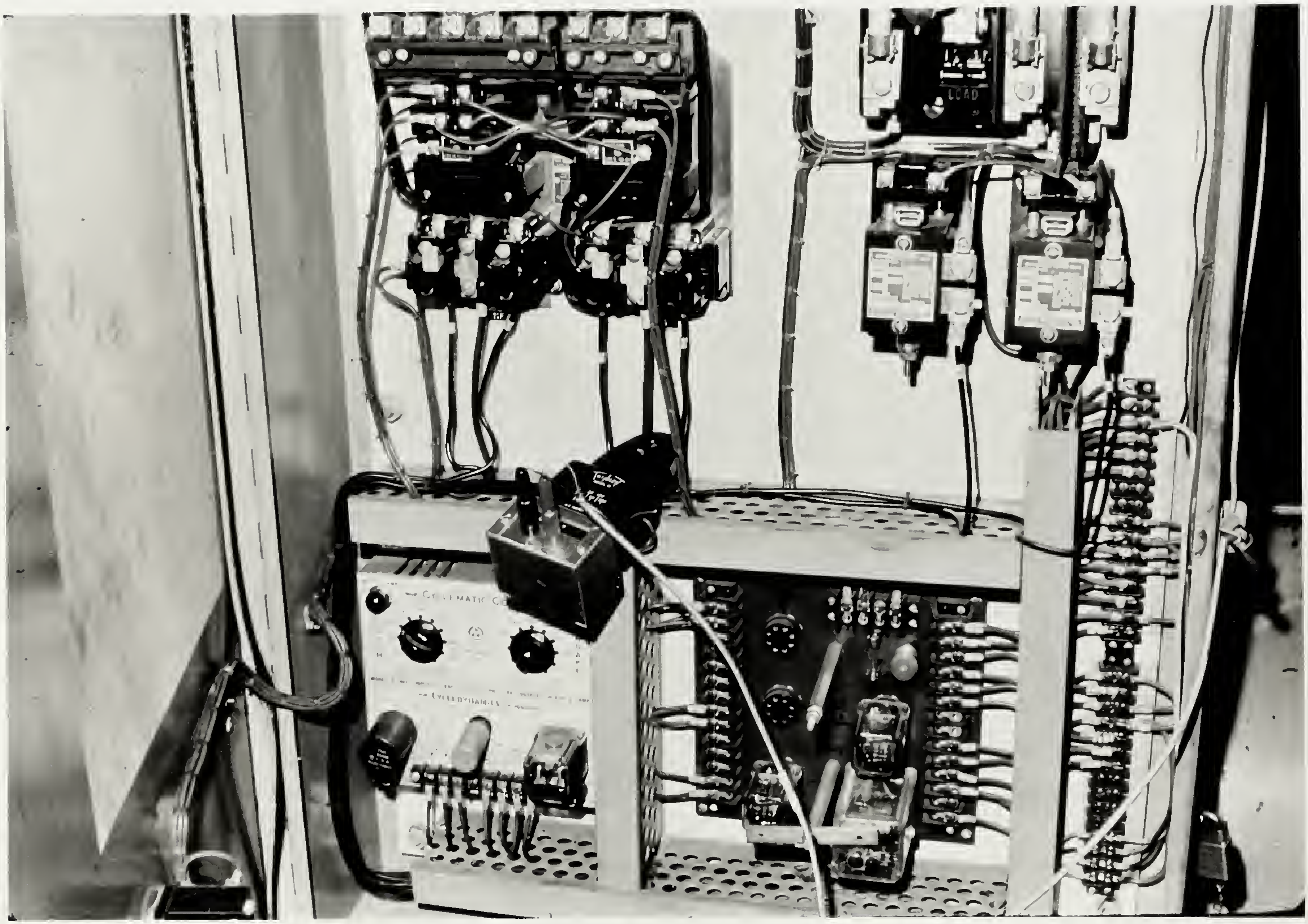
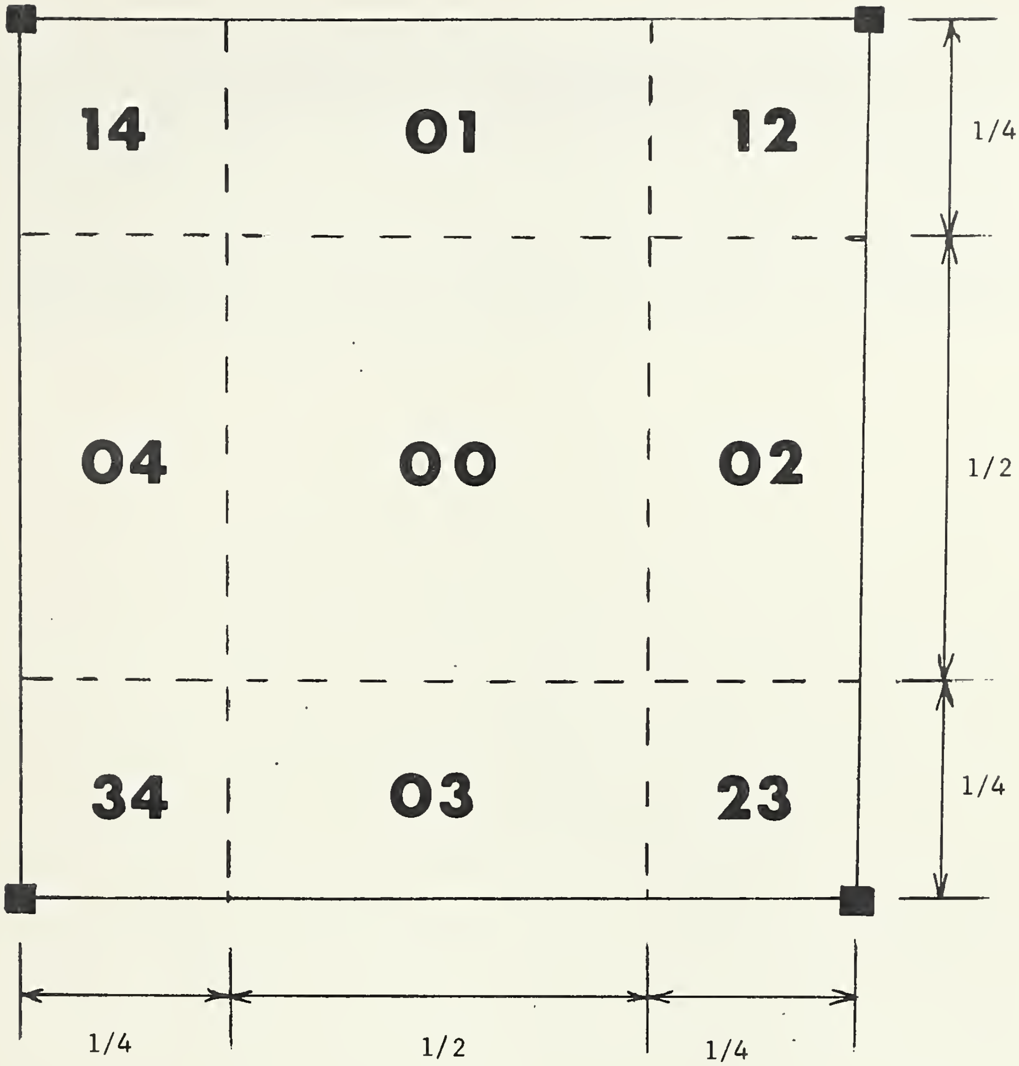


FIG. 5 - INTERIOR OF CONTROL PANEL FOR CONVEYOR DRIVE MOTOR SHOWING CLAMP-ON AMMETER ENCIRCLING MOTOR LEAD WIRE.



Code number is related to an actual direction, e.g.:

00 = Central	03 = South
01 = North	34 = Southwest
12 = Northeast	04 = West
02 = East	14 - Northwest
23 = Southeast	

FIG. 6 - GENERAL SCHEME FOR LOCATING ITEMS ON FLOOR OF POST OFFICE WITHIN A COLUMN GRID SQUARE.

FIG. 7 - PLAN OF GREENSBORO POST OFFICE MECHANIZATION SHOWING SECTIONS SELECTED FOR ESTIMATION OF MECHANIZATION DEAD WEIGHT.

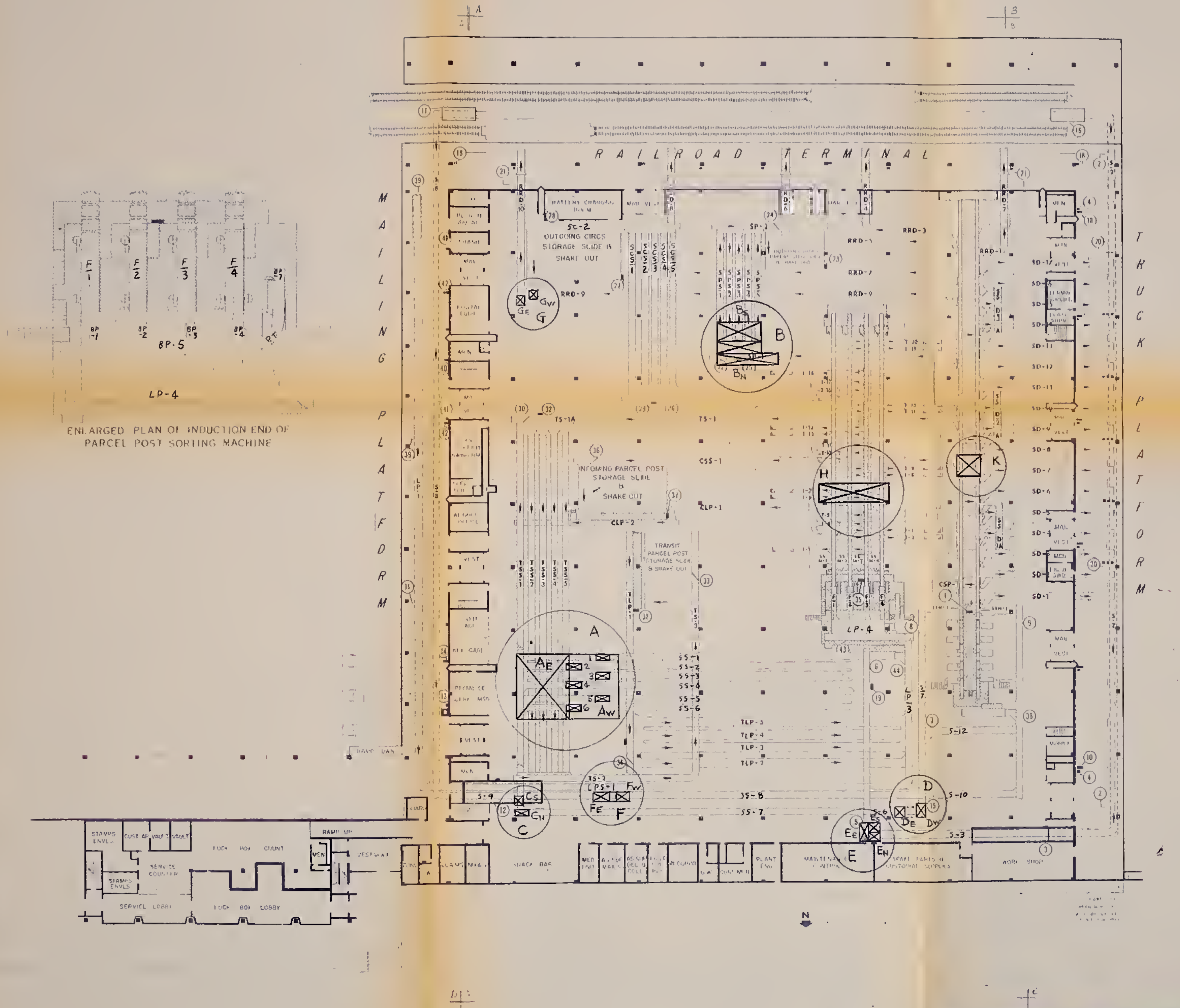


FIG. 7 PLAN OF GREENSBORO POST OFFICE MECHANIZATION SHOWING SECTIONS SELECTED FOR ESTIMATION OF MECHANIZATION DEAD WEIGHT.

SAMPLE SIZE IS 443 MAXIMUM VALUE IS 11.943
TOLERANCE LIMITS (.00, 8.80) FOR COVERAGE= .90, PROBABILITY= .90
STANDARD DEVIATION= 2.9 MEAN= 3.8

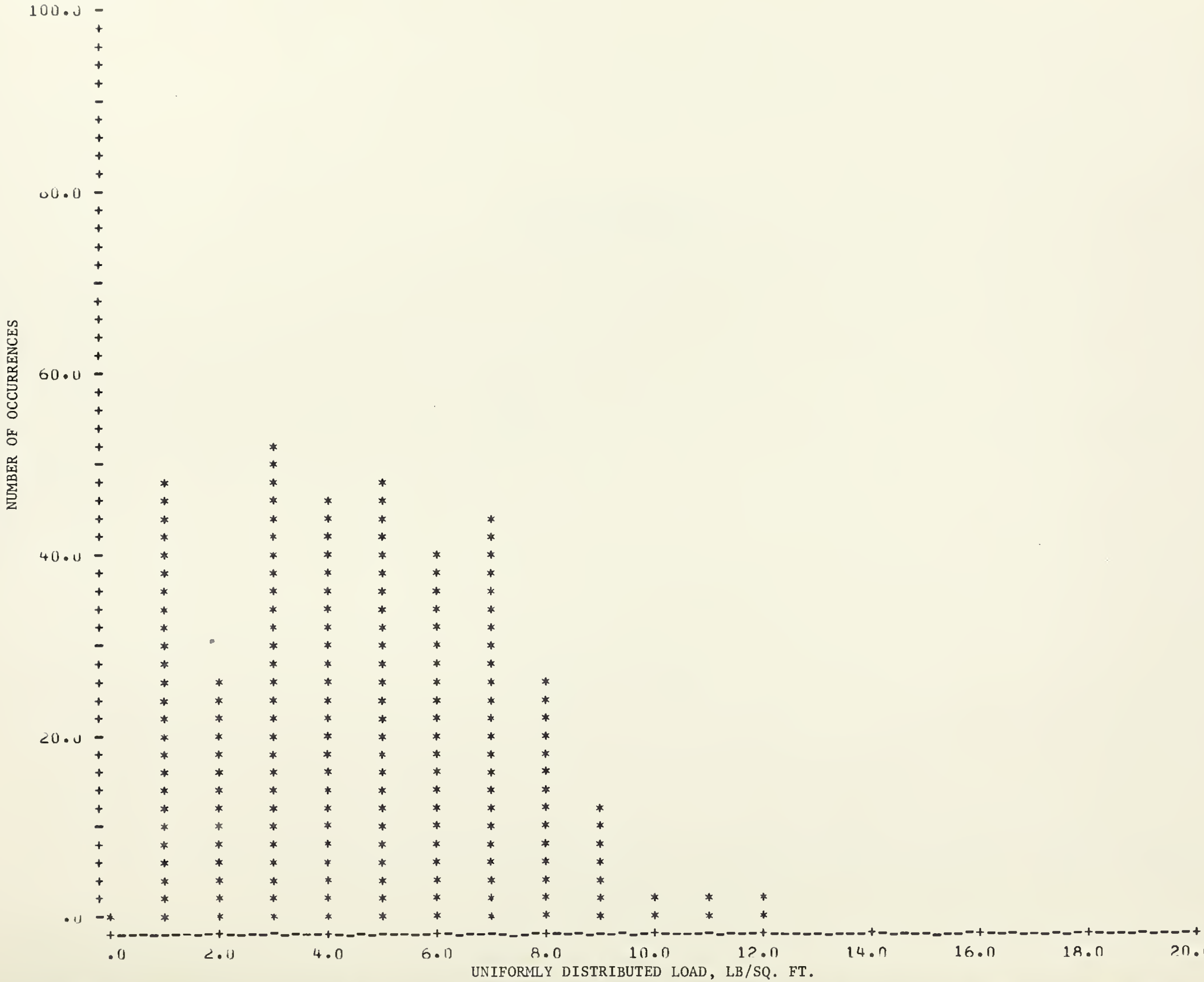


FIG. 8 - FREQUENCY DISTRIBUTION OF OBSERVED BELT LOADINGS IN LB/SQ. FT. BASED ON SUMS OF STRINGS OR 5 CONSECUTIVE WEIGH-PLATE READINGS.

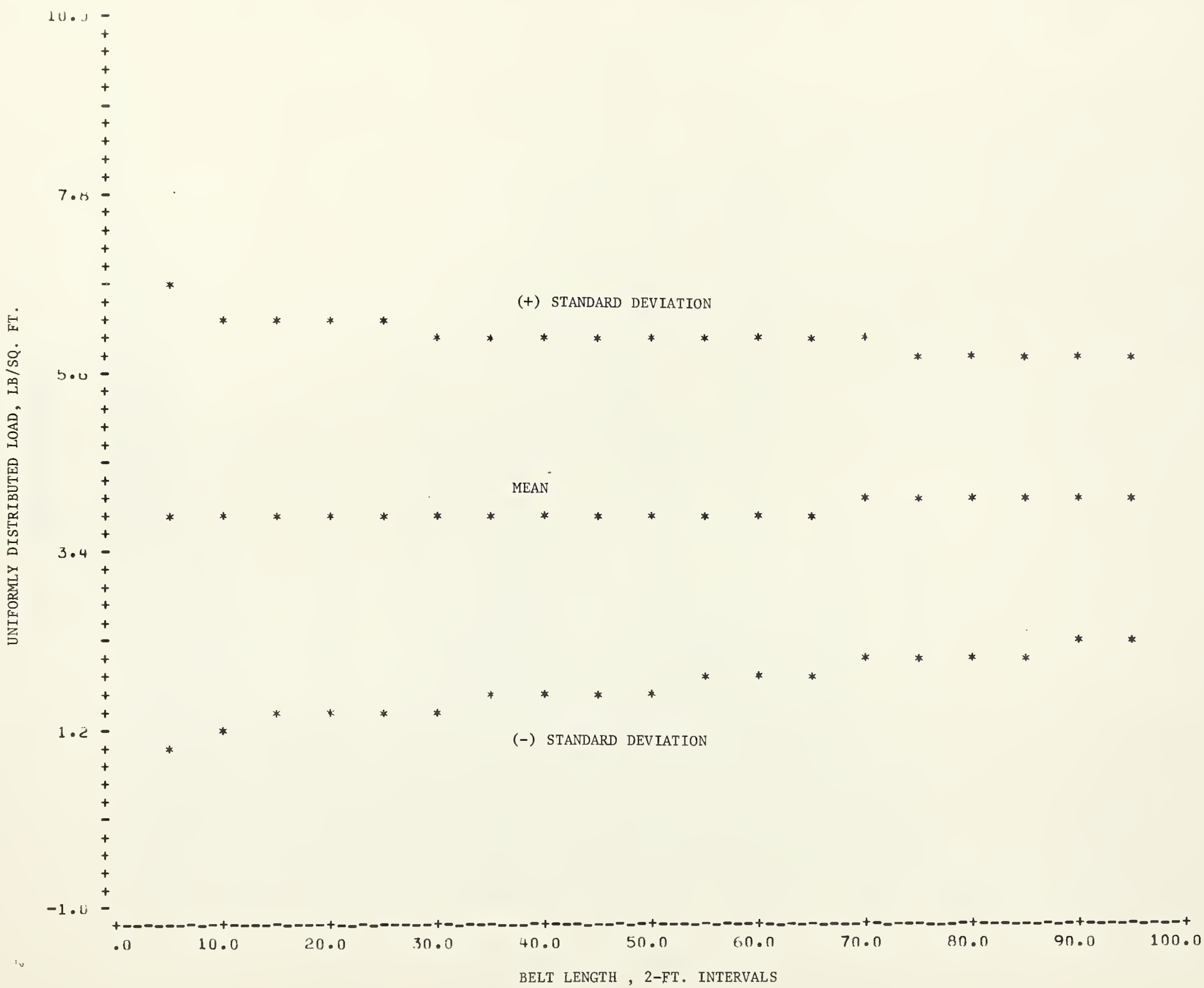


FIG. 9 - PLOT OF [MEAN BELT LOADINGS (LB./SQ. FT.) ± STANDARD DEVIATION] VS. [BELT LENGTH IN 2-FT. INTERVALS]; VALUES FROM TABLE 3.

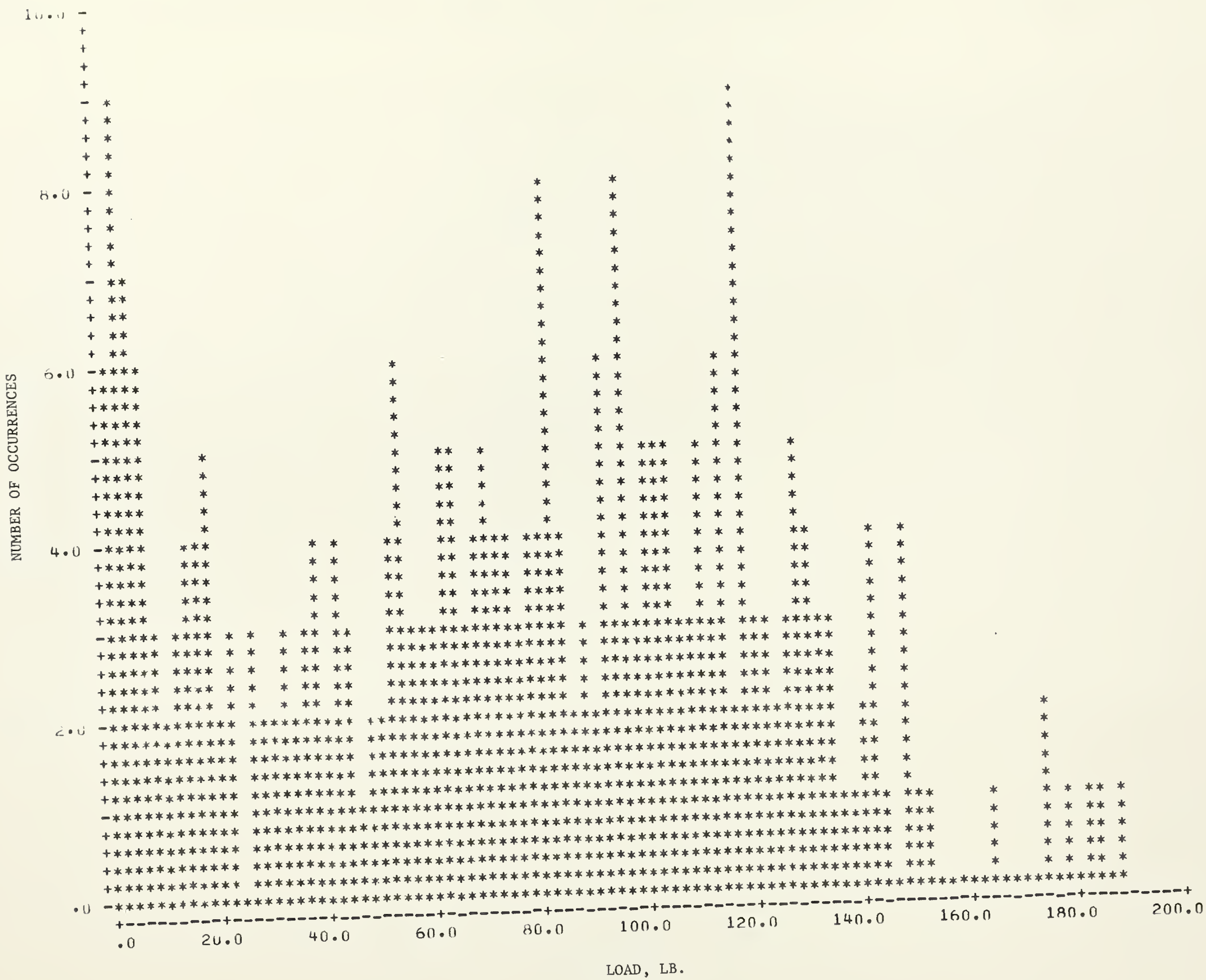


FIG. 10 - FREQUENCY DISTRIBUTION OF CALCULATED HANGER LOADS BASED ON OBSERVED WEIGH-PLATE READINGS.

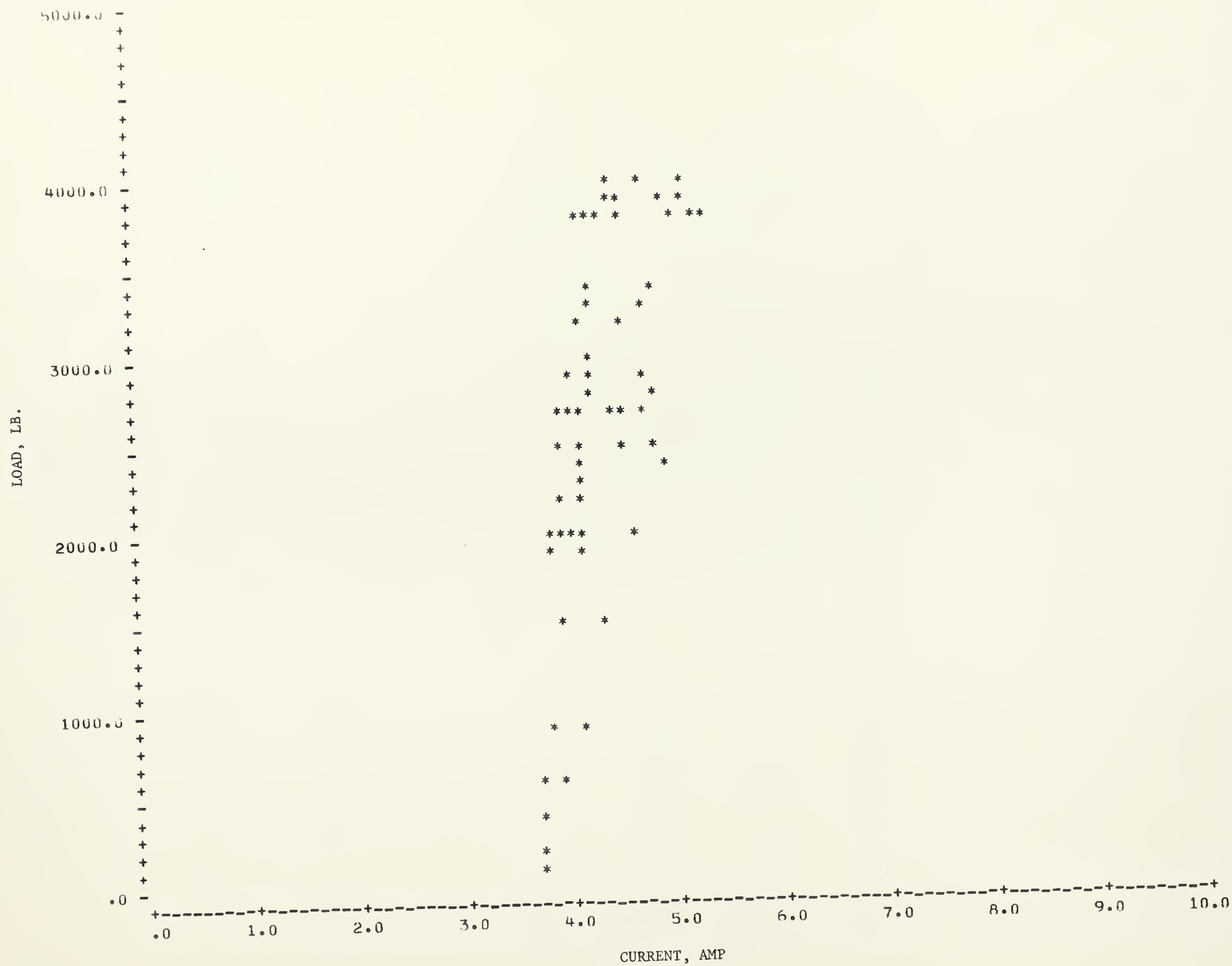


FIG. 11 - [LOAD (LBS.) ON ENTIRE LENGTH (91, 2-FT. INTERVALS) OF CONVEYOR BELT] VS. [CURRENT (AMPS) MEASURED IN DRIVE MOTOR LINE].

FIG. 12 - SAMPLE OF FREQUENCY DISTRIBUTION OF MAXIMUM MEASURED HANGER LOADS IN 11 PERIODS.

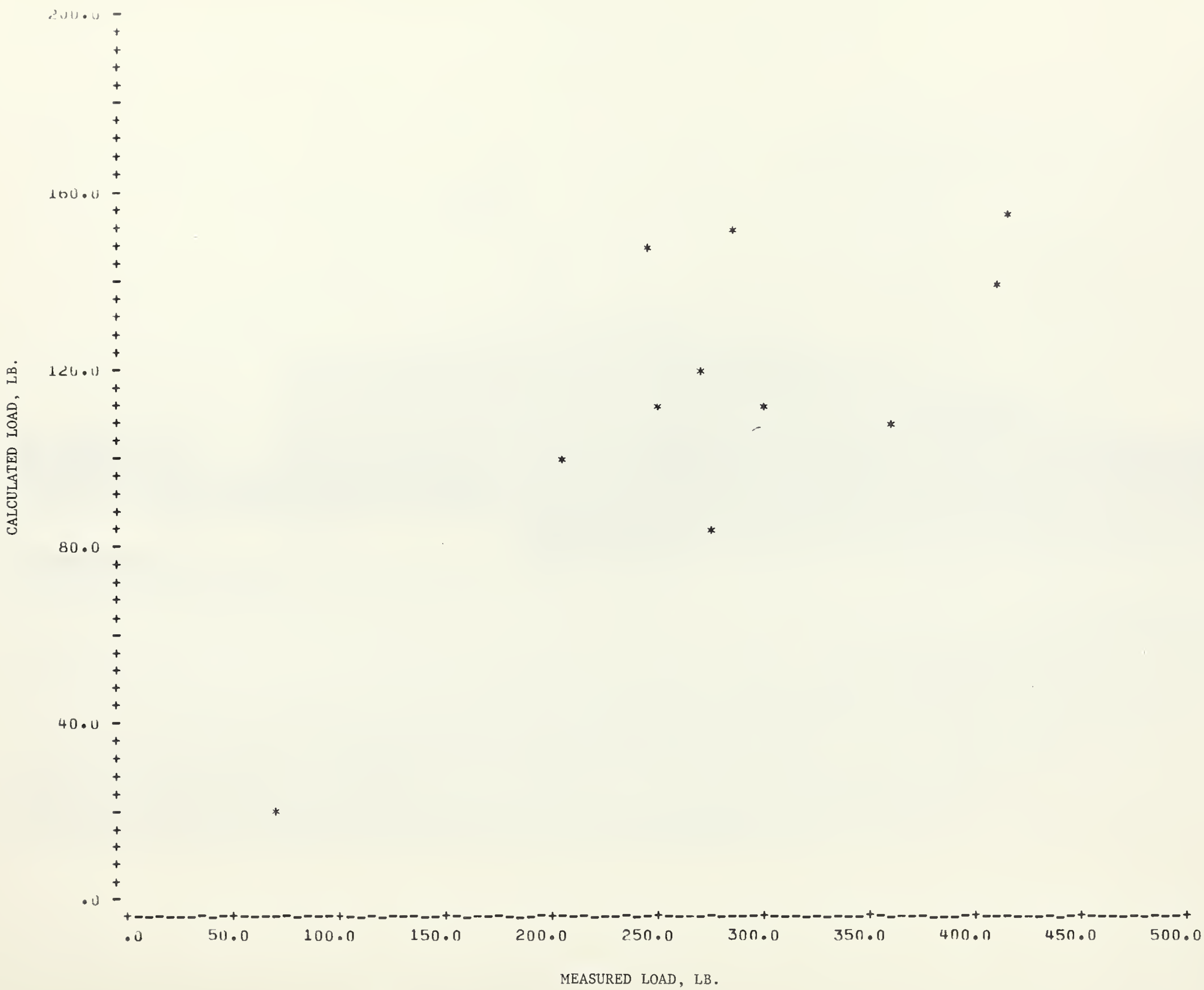


FIG. 13 - PLOT OF CALCULATED HANGER LOADS (FROM WEIGH-PLATE READINGS) VS. MAXIMUM MEASURED LOADS IN 11 PERIODS.

FIG. 14 - U.S. POST OFFICE AT GREENSBORO, NORTH CAROLINA: CITY POST OFFICE, NATIONAL DISTRIBUTION CENTER, CENTRAL DISTRIBUTION UNIT, AND SECTIONAL CENTER.

FIG. 15 - FLOOR PLAN OF POST OFFICE AT GREENSBORO, NORTH CAROLINA, SHOWING MAIL HANDLING WORK ROOM.

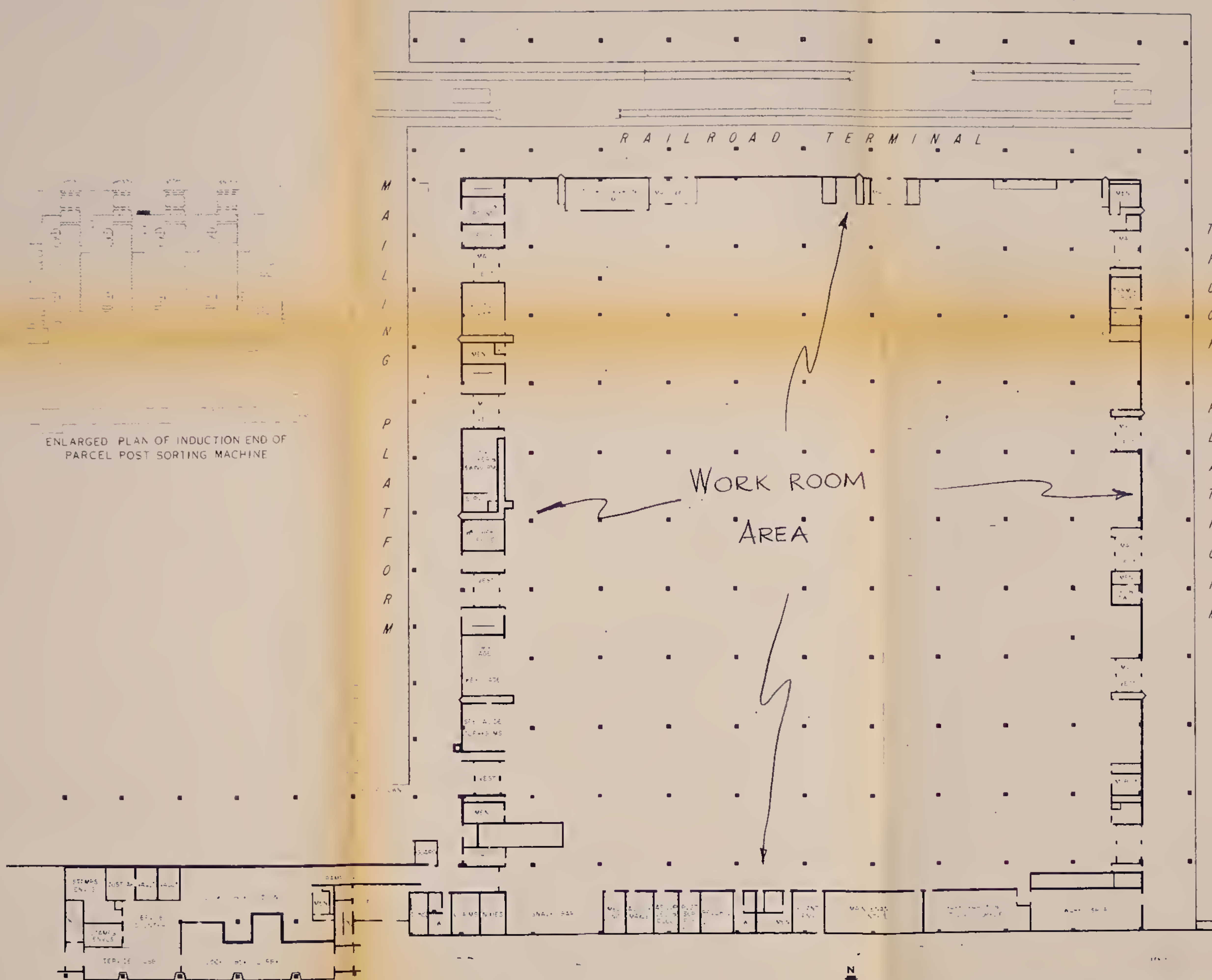


FIG. 15 · FLOOR PLAN OF POST OFFICE AT GREENSBORO, NORTH CAROLINA. SHOWING MAIL HANDLING WORK ROOM.

FIG. 16 - METHOD OF LABELING COLUMNN GRID SQUARES.

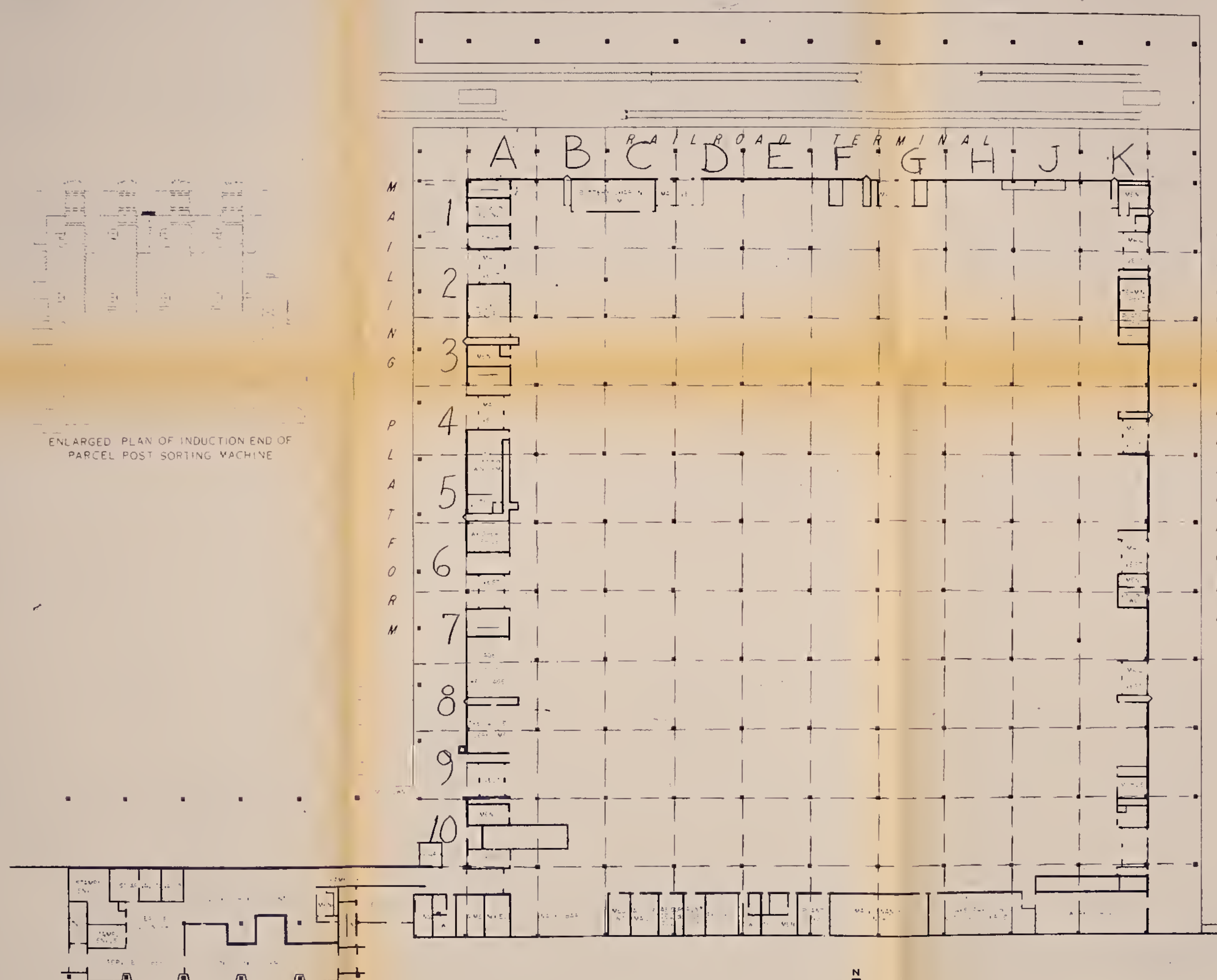


FIG. 16 - METHOD OF LABELING COLUMNN GRID SQUARES.

FIG. 17 - GREENSBORO POST OFFICE FLOOR PLAN SHOWING DESIGNATED SPECIFIC WORK AREAS.

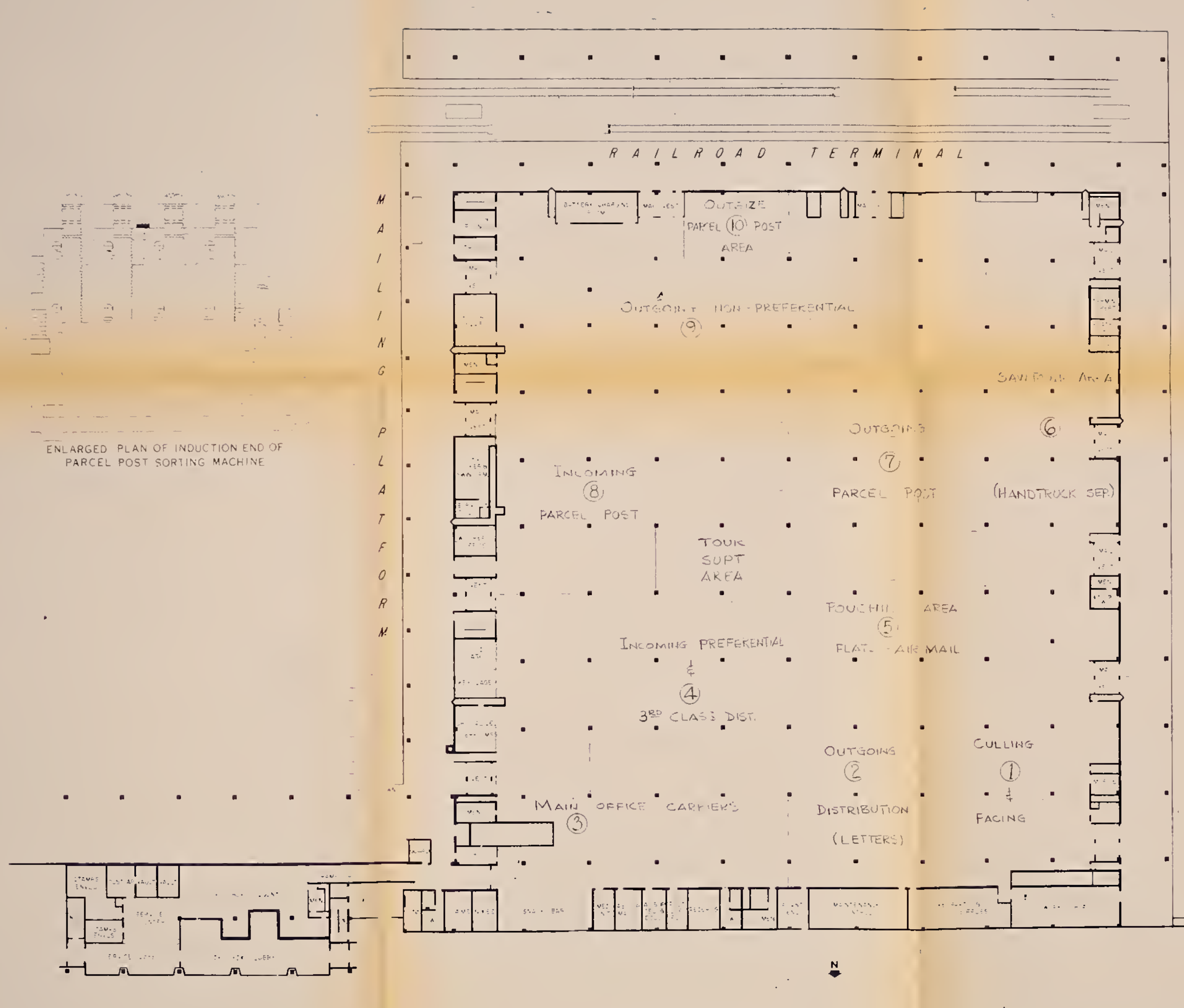
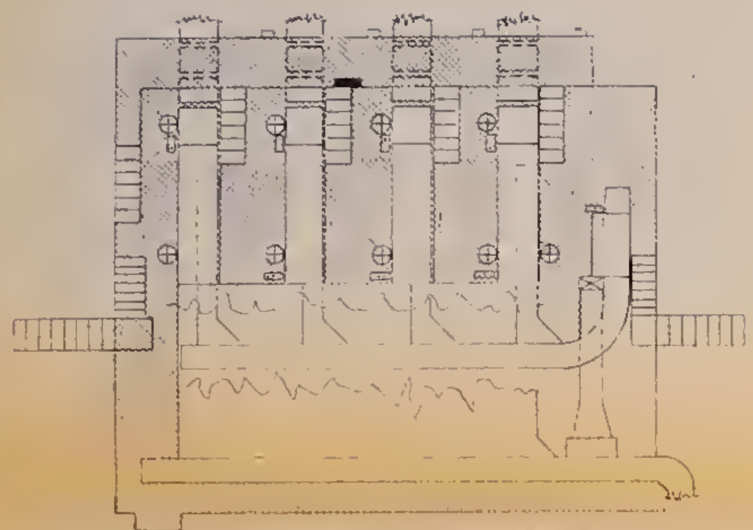


FIG. 17 - GREENSBORO POST OFFICE FLOOR PLAN SHOWING DESIGNATED SPECIFIC WORK AREAS.

FIG. 18 - PLAN OF OVERALL MECHANIZATION SYSTEM AT GREENSBORO, NORTH CAROLINA, POST OFFICE.



.ENLARGED PLAN OF INDUCTION END OF PARCEL POST SORTING MACHINE

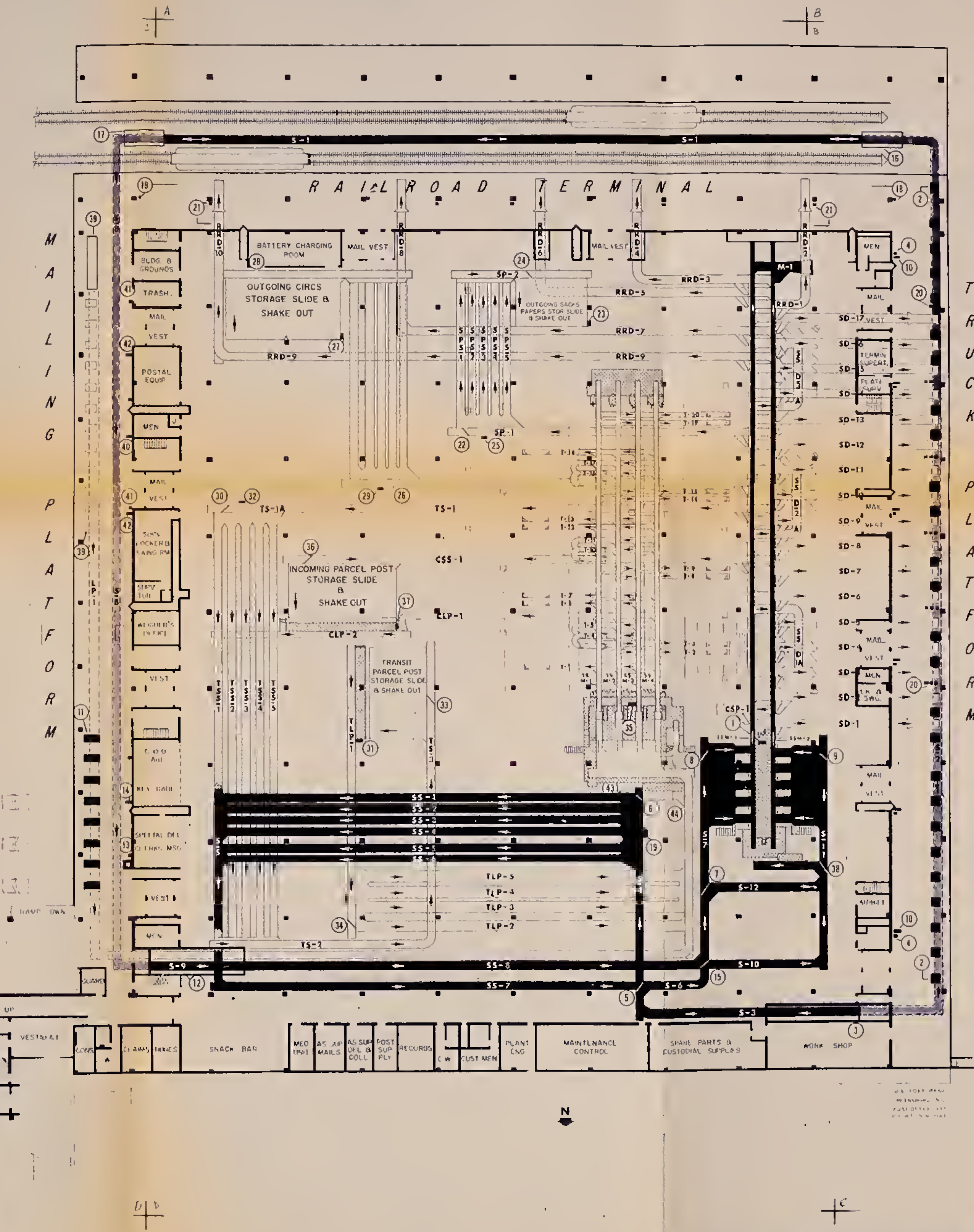
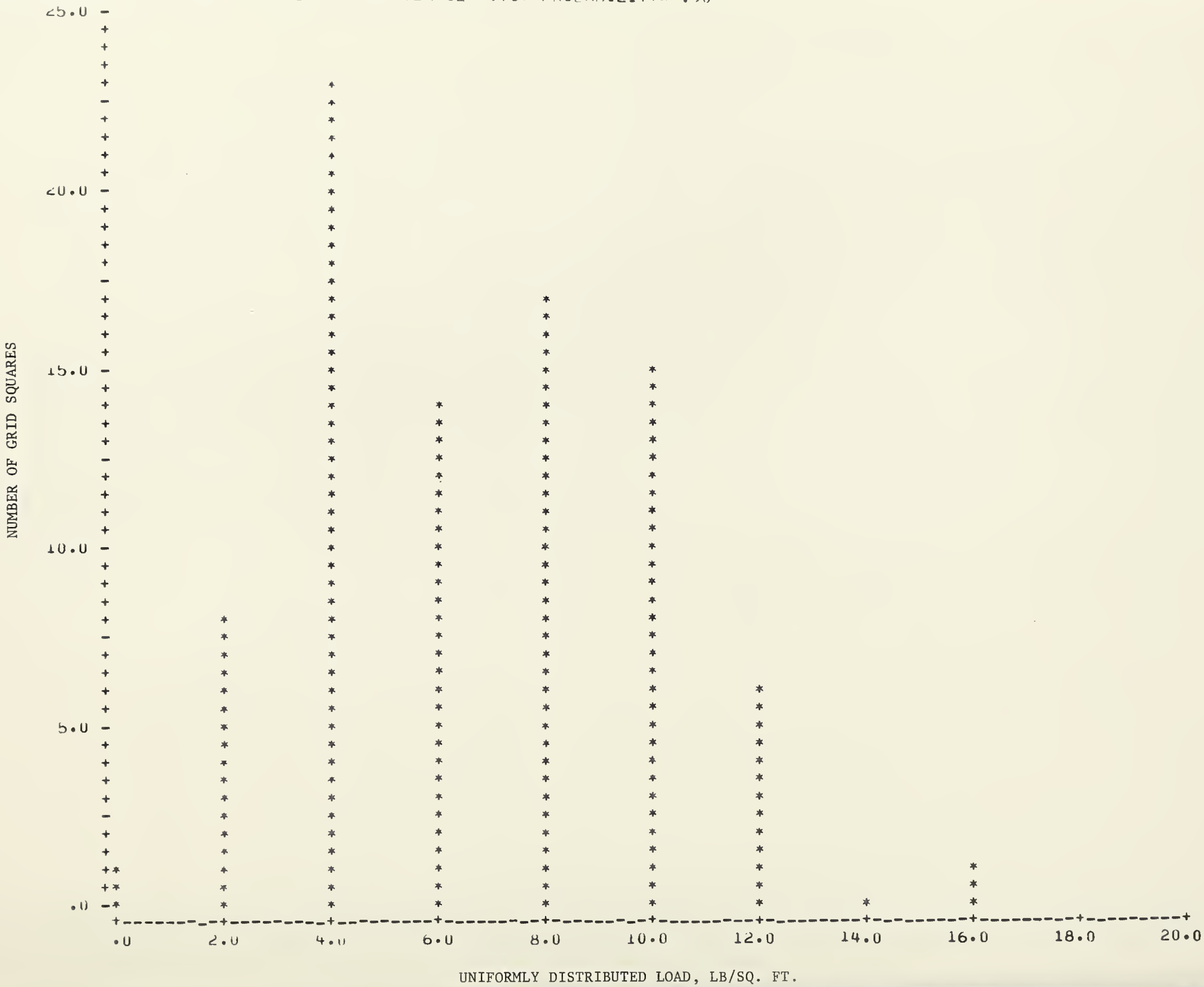


FIG. 18 · PLAN OF OVERALL MECHANIZATION SYSTEM AT GREENSBORO, NORTH CAROLINA, POST OFFICE.

FREQUENCY DISTRIBUTION FOR DISTRIBUTED GRID SQUARE LOADS FOR BDG.T. N= 85

GREENSBORO POST OFFICE

STANDARD DEVIATION= 3.1 MEAN= 6.7
TOLERANCE LIMITS (2.67, 10.98) FOR COVERAGE= .75, PROBABILITY= .90



FREQUENCY DIST.OF PERCENT OF OCCUPIED SPACE OF GRID SQUARES FOR BDG.T. N= 85 GREENSBORO POST OFFICE
STANDARD DEVIATION= 8.7 MEAN= 22.8
TOLERANCE LIMITS (10.46, 33.41) FOR COVERAGE= .75, PROBABILITY= .90

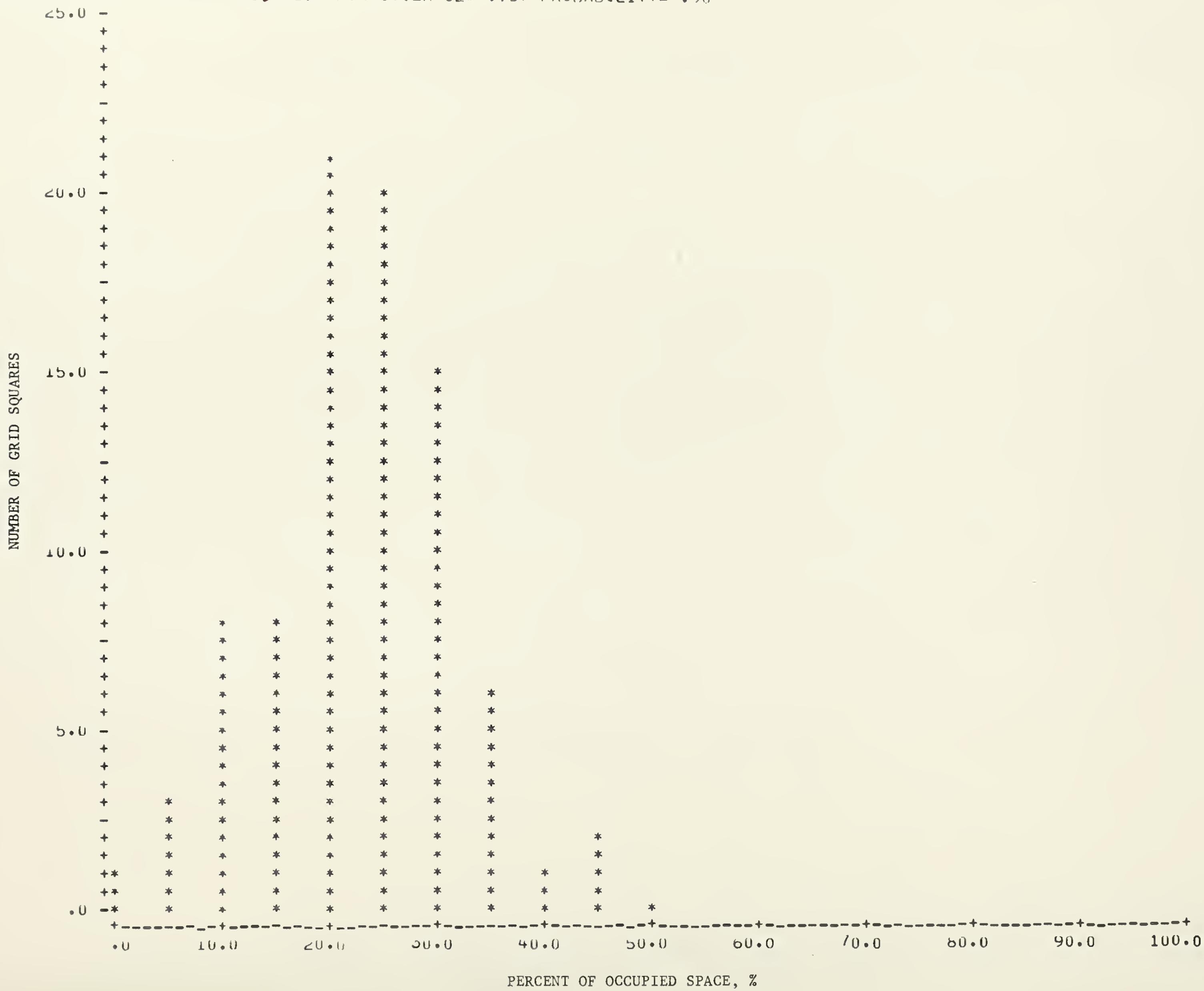


FIG. 20 - FREQUENCY DISTRIBUTION OF PERCENTAGE OF OCCUPIED SPACE BY GRID SQUARES FOR TOTAL WORKROOM AREA.

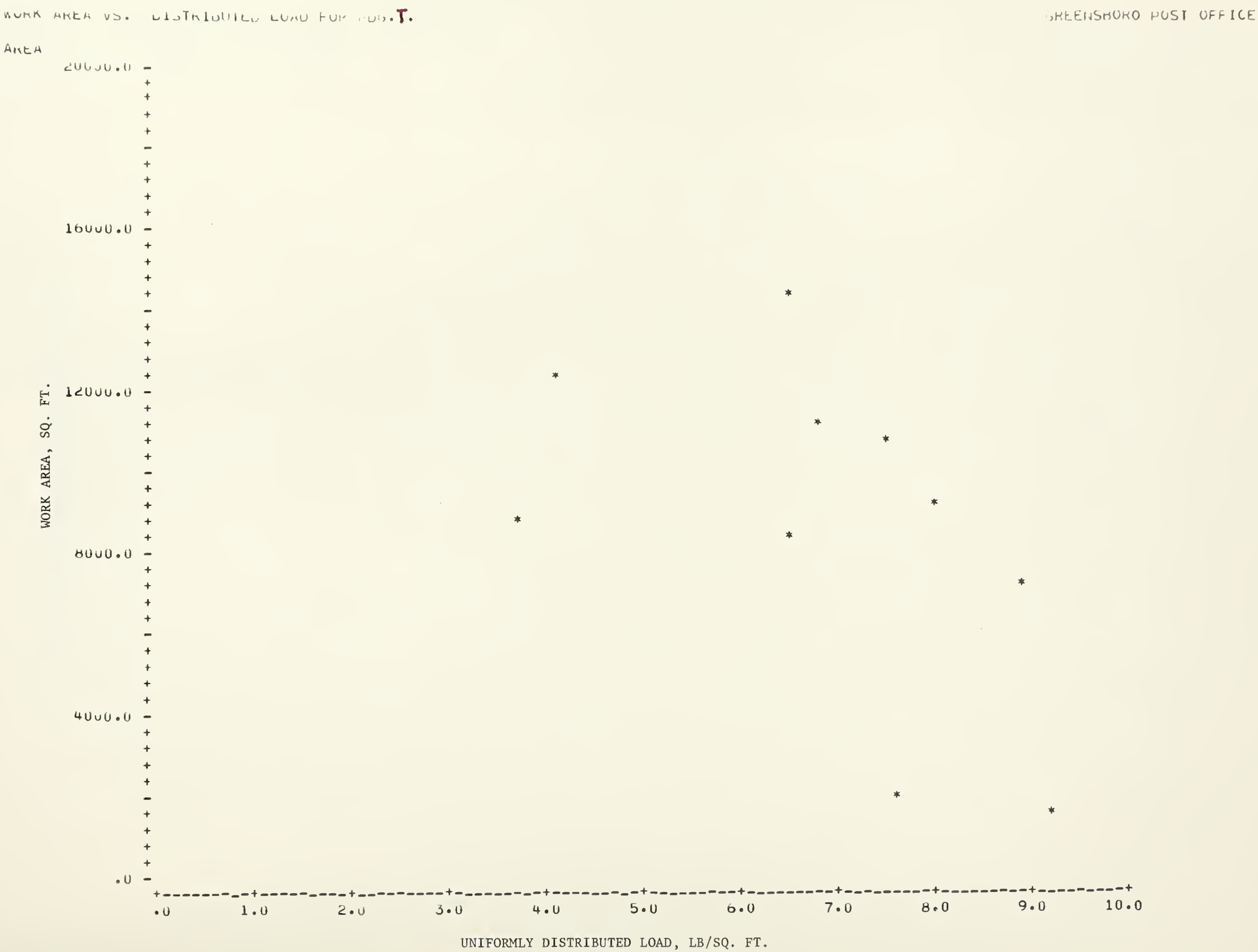


FIG. 21 - RELATIONSHIP BETWEEN SIZE OF WORK AREA AND INTENSITY OF UNIFORMLY DISTRIBUTED LOAD.

CUMULATIVE FRACTIONS OF LOADED AREA CARRYING LOADS GREATER THAN A DISCRETE VALUE, WORK AREA, 1

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TOTAL AREA= 8512.0 SQ.FT.
LOADED AREA= 1740.9 SQ.FT. = 20.5 % OF TOTAL AREA
ZERO LOAD= 6771.1 SQ.FT. = 79.5 % OF TOTAL AREA
U.D.L.= 6.5 FOR TOTAL AREA

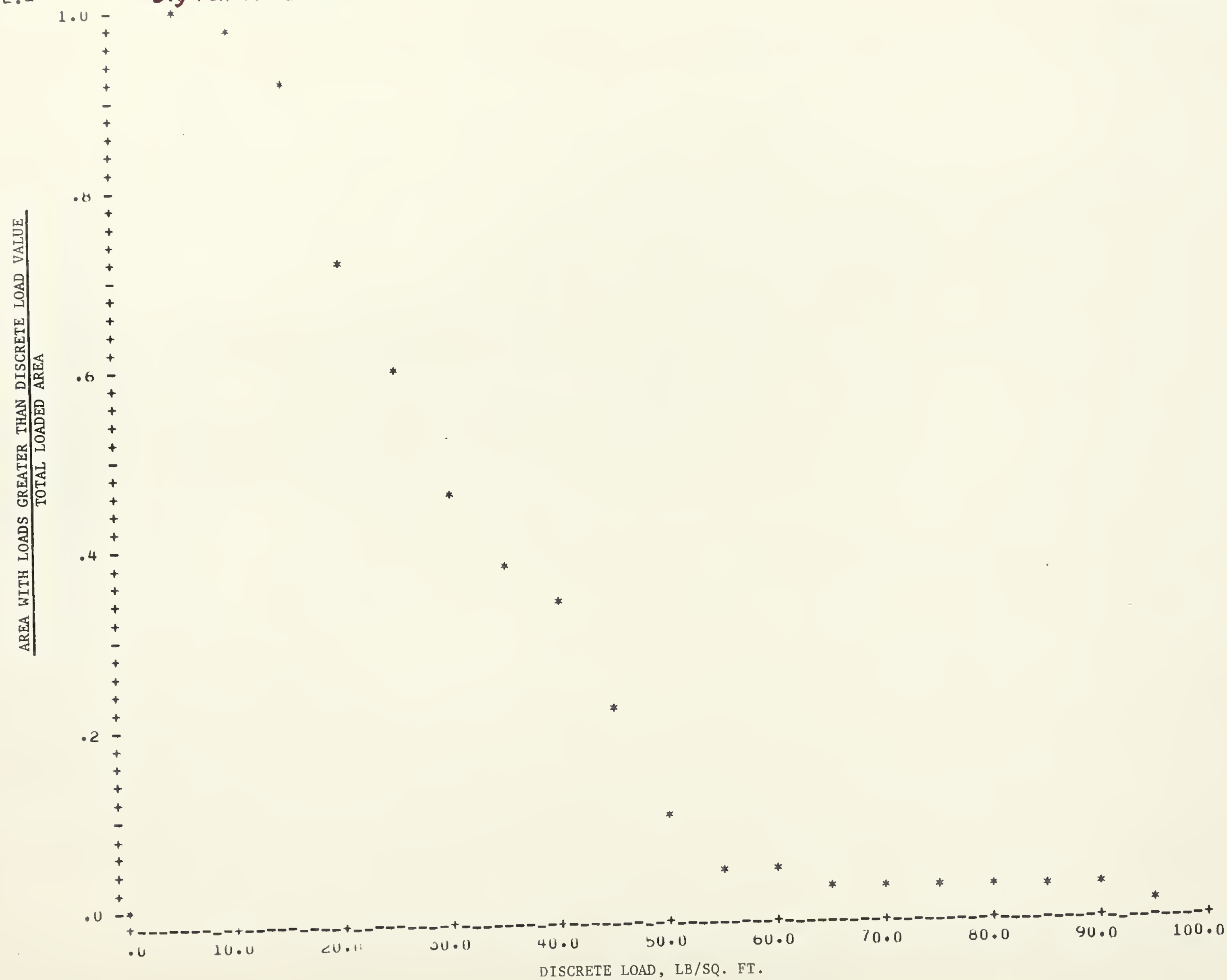

FIG. 22 - PLOT OF CUMULATIVE FRACTIONS OF LOADED AREA CARRYING LOADS GREATER THAN A DISCRETE VALUE FOR WORK AREA 1.

CUMULATIVE FRACTIONS OF LOADED AREA CARRYING LOADS GREATER THAN A DISCRETE VALUE. WORK AREA 2

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TOTAL AREA= 7392.0 SQ.FT.
LOADED AREA= 2069.8 SQ.FT. = 28.0 % OF TOTAL AREA
ZERO LOAD= 5322.2 SQ.FT. = 72.0 % OF TOTAL AREA
U.D.L.= 8.9 PSF TOTAL AREA

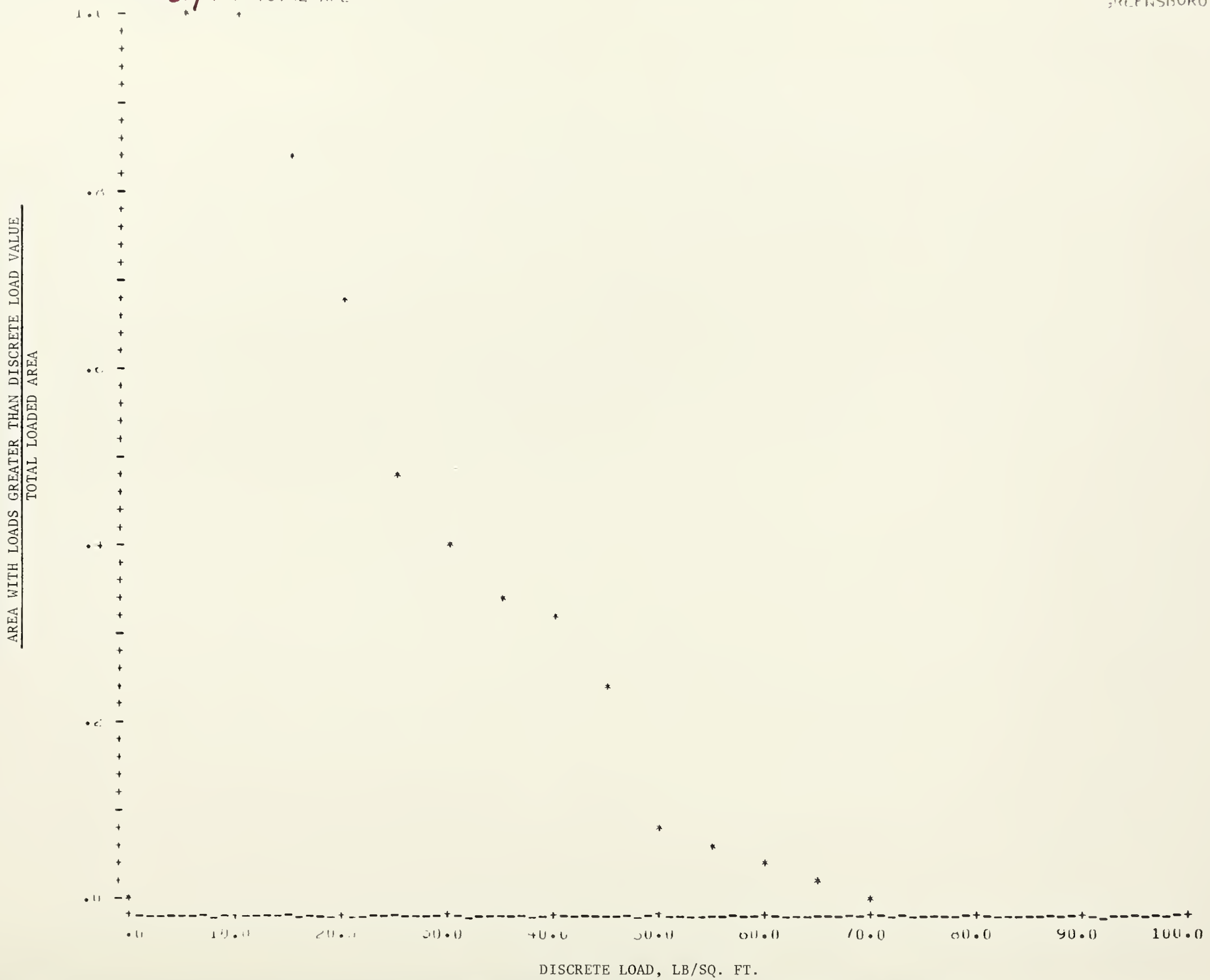

FIG. 23 - PLOT OF CUMULATIVE FRACTIONS OF LOADED AREA CARRYING LOADS GREATER THAN A DISCRETE VALUE FOR WORK AREA 2.

CUMULATIVE FRACTIONS OF LOADED AREA CARRYING LOADS GREATER THAN A DISCRETE VALUE, WORK AREA, 3
TOTAL AREA= 10806.0 SQ.FT.
LOADED AREA= 2249.1 SQ.FT. = 20.8 % OF TOTAL AREA
ZERO LOAD= 8556.9 SQ.FT. = 79.2 % OF TOTAL AREA
U.D.L.= 7.5 FOR TOTAL AREA

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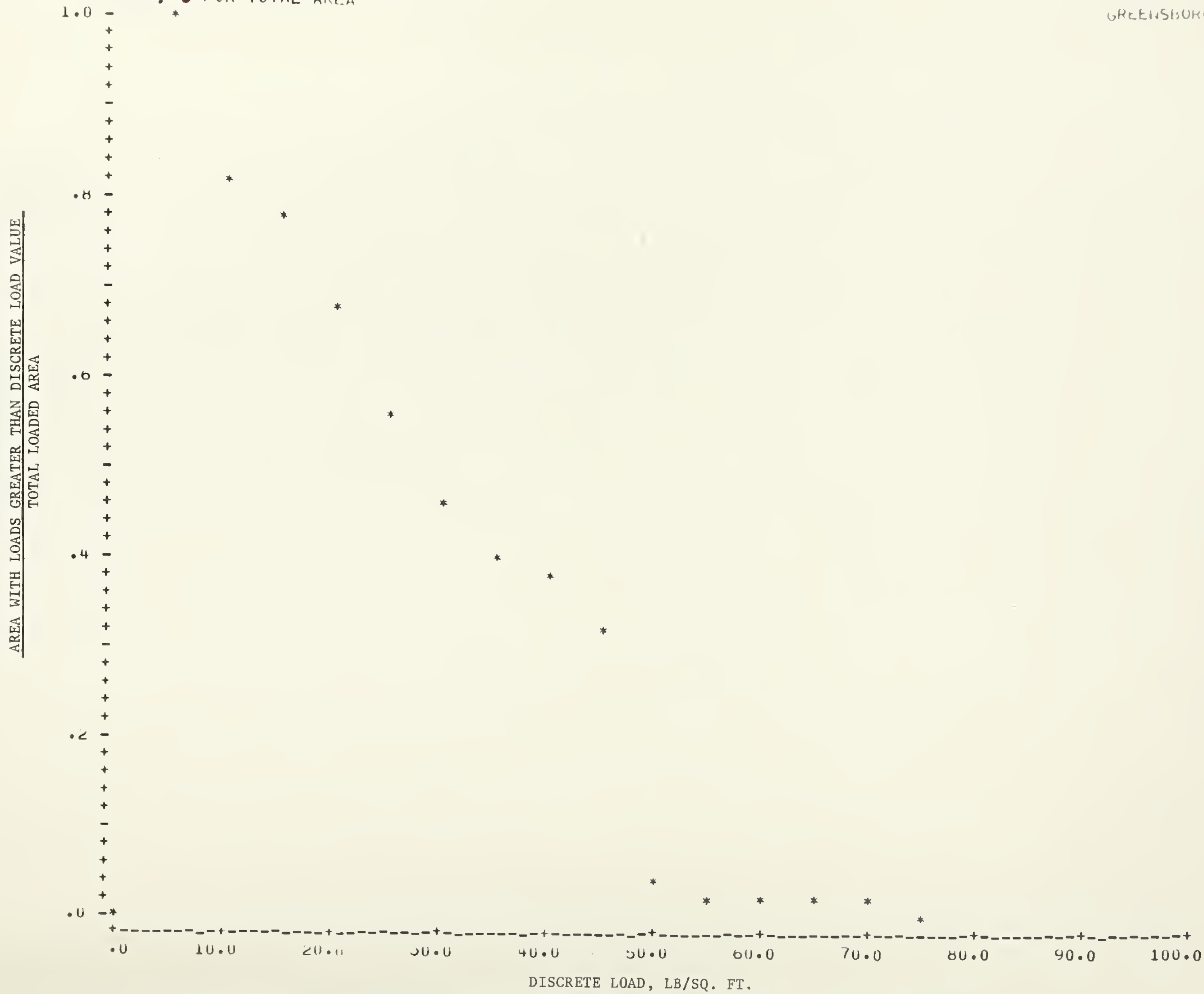

FIG. 24 - PLOT OF CUMULATIVE FRACTIONS OF LOADED AREA CARRYING LOADS GREATER THAN A DISCRETE VALUE FOR WORK AREA 3.

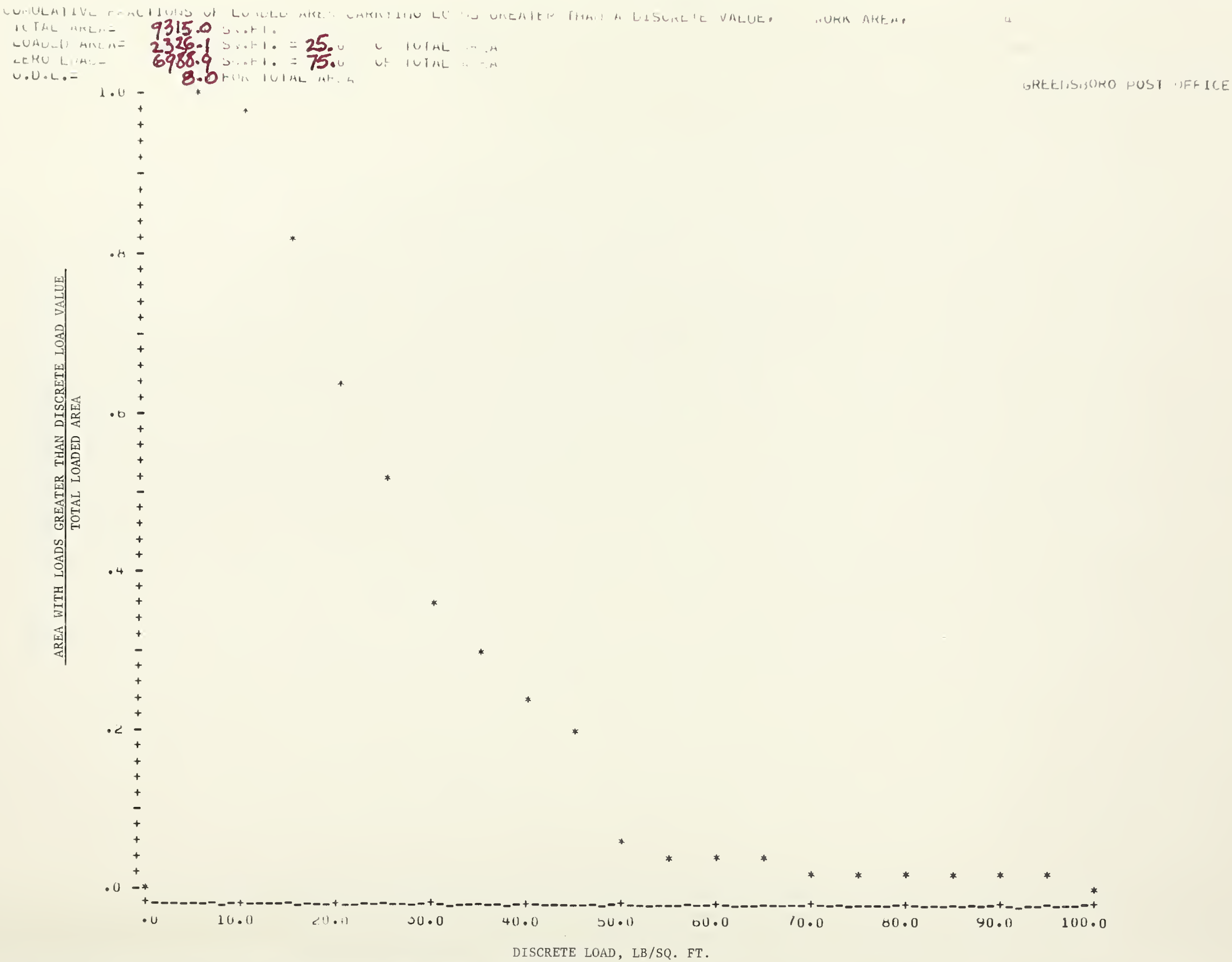

FIG. 25 - PLOT OF CUMULATIVE FRACTIONS OF LOADED AREA CARRYING LOADS GREATER THAN A DISCRETE VALUE FOR WORK AREA 4.

CUMULATIVE FRACTIONS OF LOADED AREA CARRYING LOADS GREATER THAN A DISCRETE VALUE, WORK AREA, 5

TOTAL AREA= 2069.0 SQ.FT.

LOADED AREA= 511.3 SQ.FT. = 24.7 % OF TOTAL AREA

ZERO LOAD= 1557.7 SQ.FT. = 75.3 % OF TOTAL AREA

U.D.L.= 7.6 FOR TOTAL AREA

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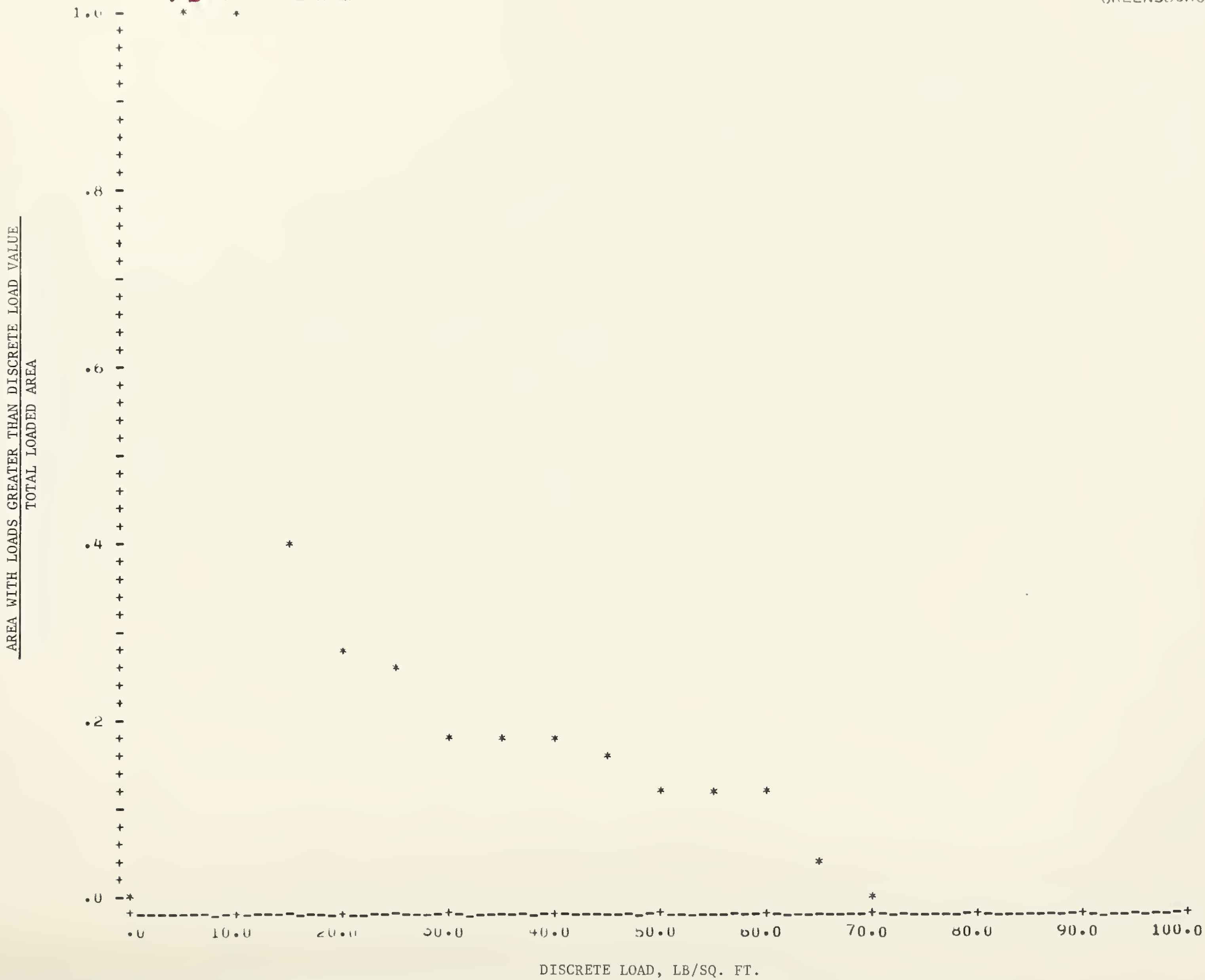

FIG. 26 - PLOT OF CUMULATIVE FRACTIONS OF LOADED AREA CARRYING LOADS GREATER THAN A DISCRETE VALUE FOR WORK AREA 5.

CUMULATIVE FRACTIONS OF LOADED AREA CARRYING LOADS GREATER THAN A DISCRETE VALUE.   WORK AREA,   6

TOTAL AREA=   11298.0 SQ.FT.

LOADED AREA=   2006.5 SQ.FT. = 17.8 % OF TOTAL AREA

ZERO LOAD=   9291.5 SQ.FT. = 82.2 % OF TOTAL AREA

U.D.L.=   6.8 FOR TOTAL AREA

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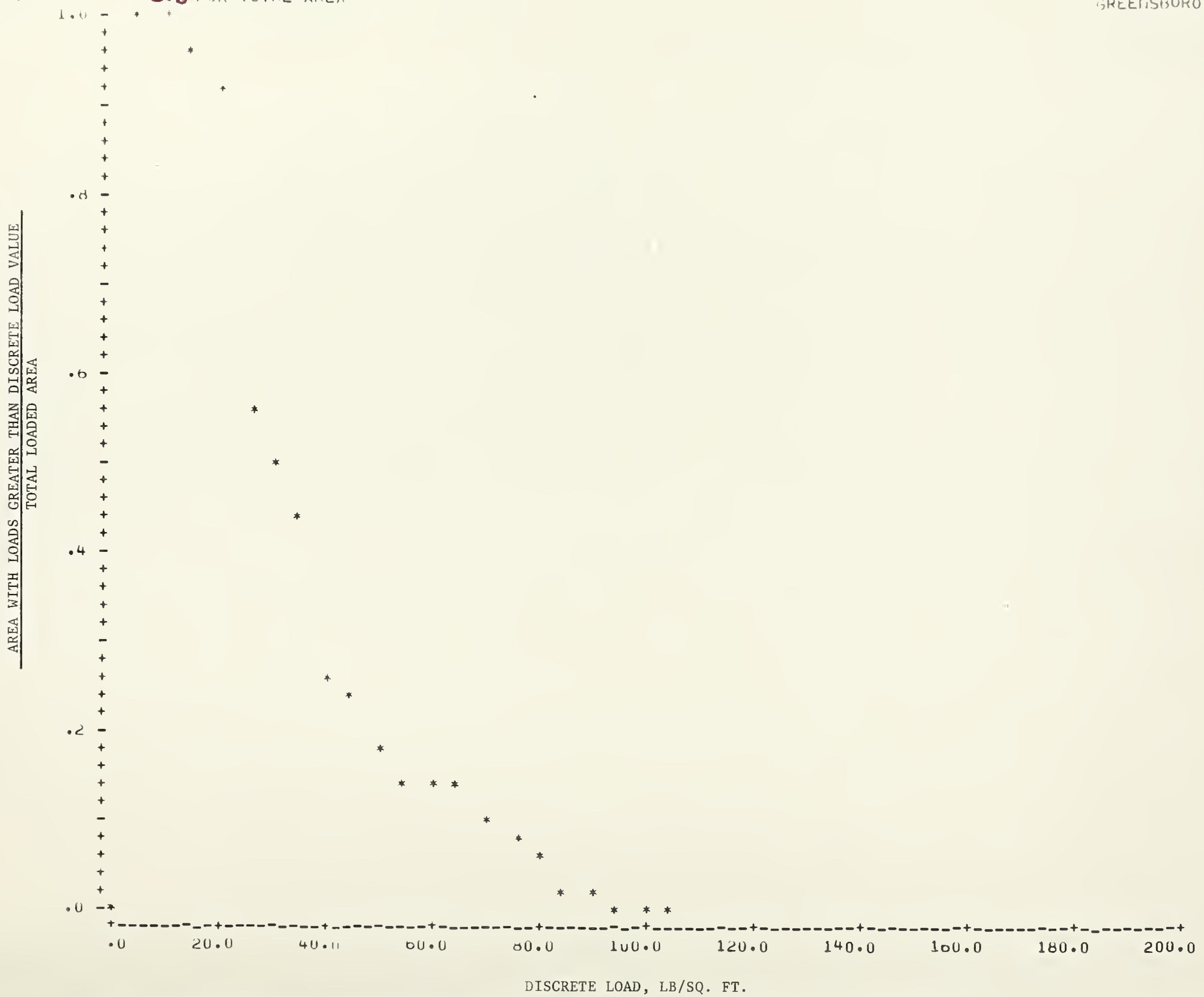

FIG. 27 - PLOT OF CUMULATIVE FRACTIONS OF LOADED AREA CARRYING LOADS GREATER THAN A DISCRETE VALUE FOR WORK AREA 6.

CUMULATIVE FRACTIONS OF LOADED AREA CARRYING LOADS GREATER THAN A DISCRETE VALUE, WORK AREA, 7

TOTAL AREA= 12306.0 SQ.FT.
LOADED AREA= 3088.3 SQ.FT. = 25.1 % OF TOTAL AREA
ZERO LOAD= 9217.7 SQ.FT. = 74.9 % OF TOTAL AREA
U.D.L.= 4.1 FOR TOTAL AREA

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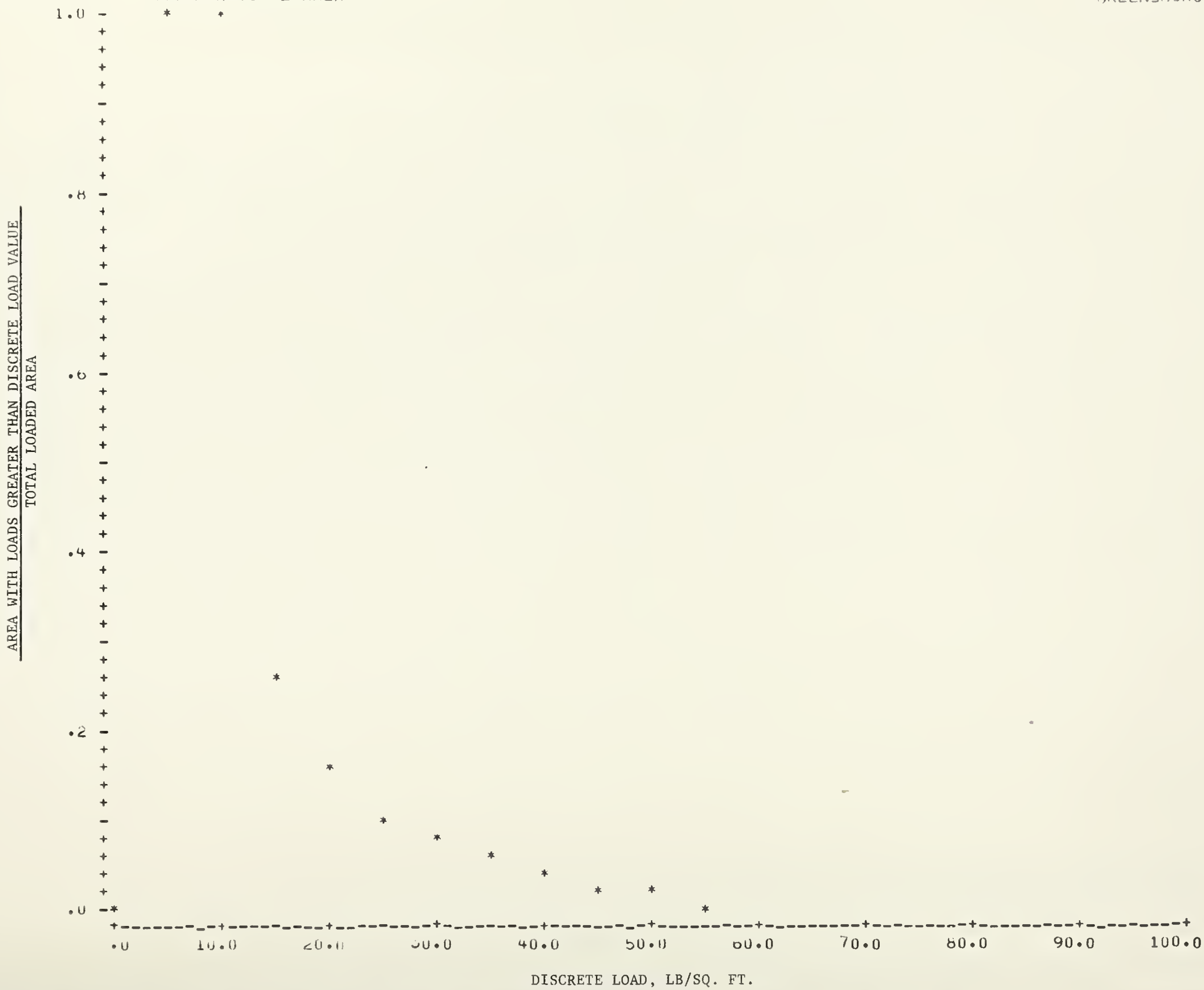

FIG. 28 - PLOT OF CUMULATIVE FRACTIONS OF LOADED AREA CARRYING LOADS GREATER THAN A DISCRETE VALUE FOR WORK AREA 7.

CUMULATIVE FRACTIONS OF LOADED AREA CARRYING LOADS GREATER THAN A DISCRETE VALUE, WORK AREA, 8

TOTAL AREA= 8671.0 SQ.FT.
LOADED AREA= 1920.3 SQ.FT. = 22.1 % OF TOTAL AREA
ZERO LOAD= 6750.7 SQ.FT. = 77.9 % OF TOTAL AREA
U.D.L.= 3.7 FOR TOTAL AREA

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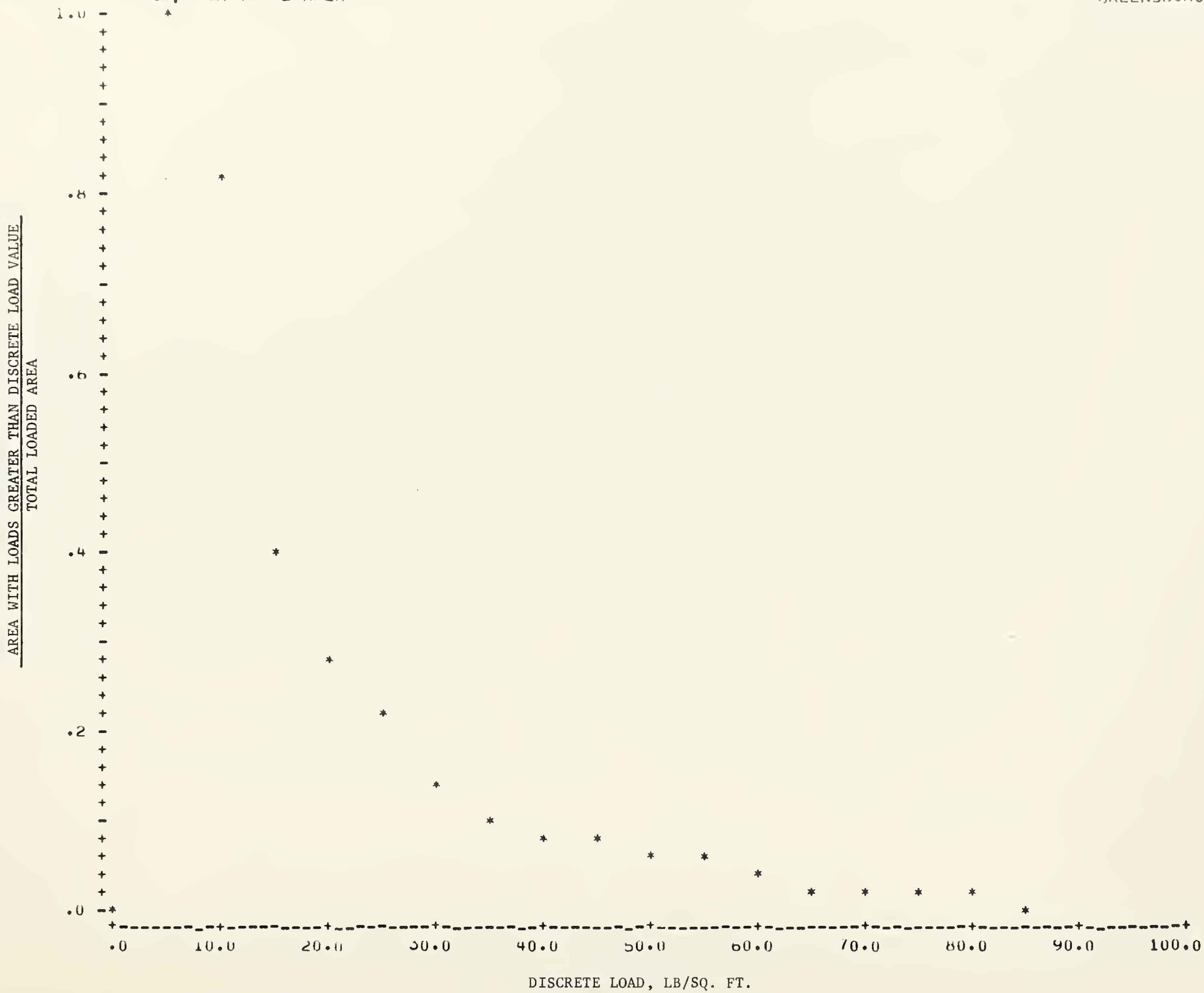

FIG. 29 - PLOT OF CUMULATIVE FRACTIONS OF LOADED AREA CARRYING LOADS GREATER THAN A DISCRETE VALUE FOR WORK AREA 8.

CUMULATIVE FRACTIONS OF LOADED AREA CARRYING LOADS GREATER THAN A DISCRETE VALUE, WORK AREA, 9

TOTAL AREA= 14535.0 SQ.FT.

LOADED AREA= 2888.6 SQ.FT. = 19.9 % OF TOTAL AREA

ZERO LOAD= 11646.4 SQ.FT. = 80.1 % OF TOTAL AREA

U.D.L.= 6.5 FOR TOTAL AREA

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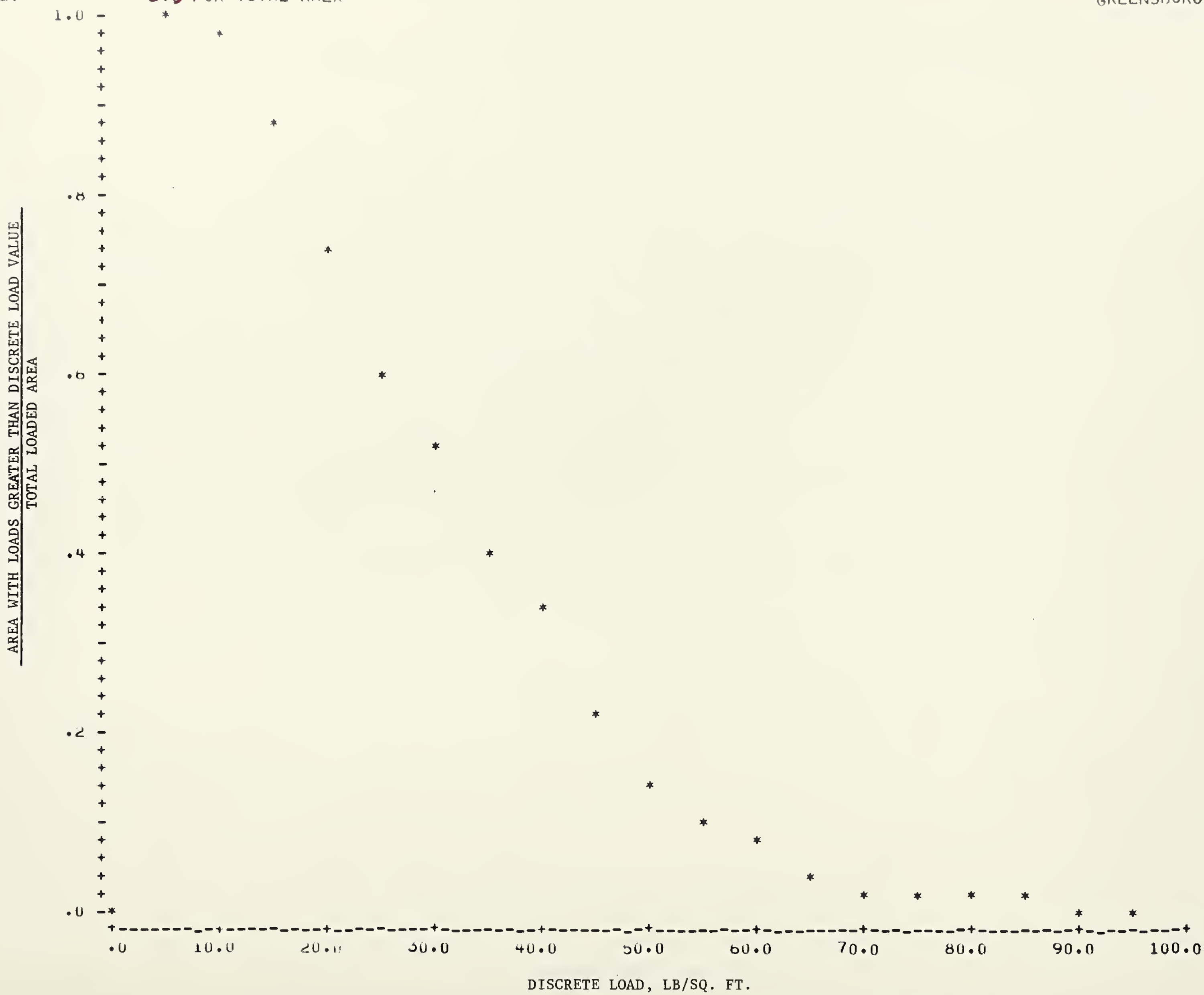

FIG. 30 - PLOT OF CUMULATIVE FRACTIONS OF LOADED AREA CARRYING LOADS GREATER THAN A DISCRETE VALUE FOR WORK AREA 9.

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CUMULATIVE FRACTIONS OF LOADED AREA CARRYING LOADS GREATER THAN A DISCRETE VALUE, WORK AREA, 10

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TOTAL AREA= 1650.0 SQ.FT.
LOADED AREA= 509.8 SQ.FT. = 30.9 % OF TOTAL AREA
ZERO LOAD= 1140.2 SQ.FT. = 69.1 % OF TOTAL AREA
U.D.L.= 9.2 FOR TOTAL AREA

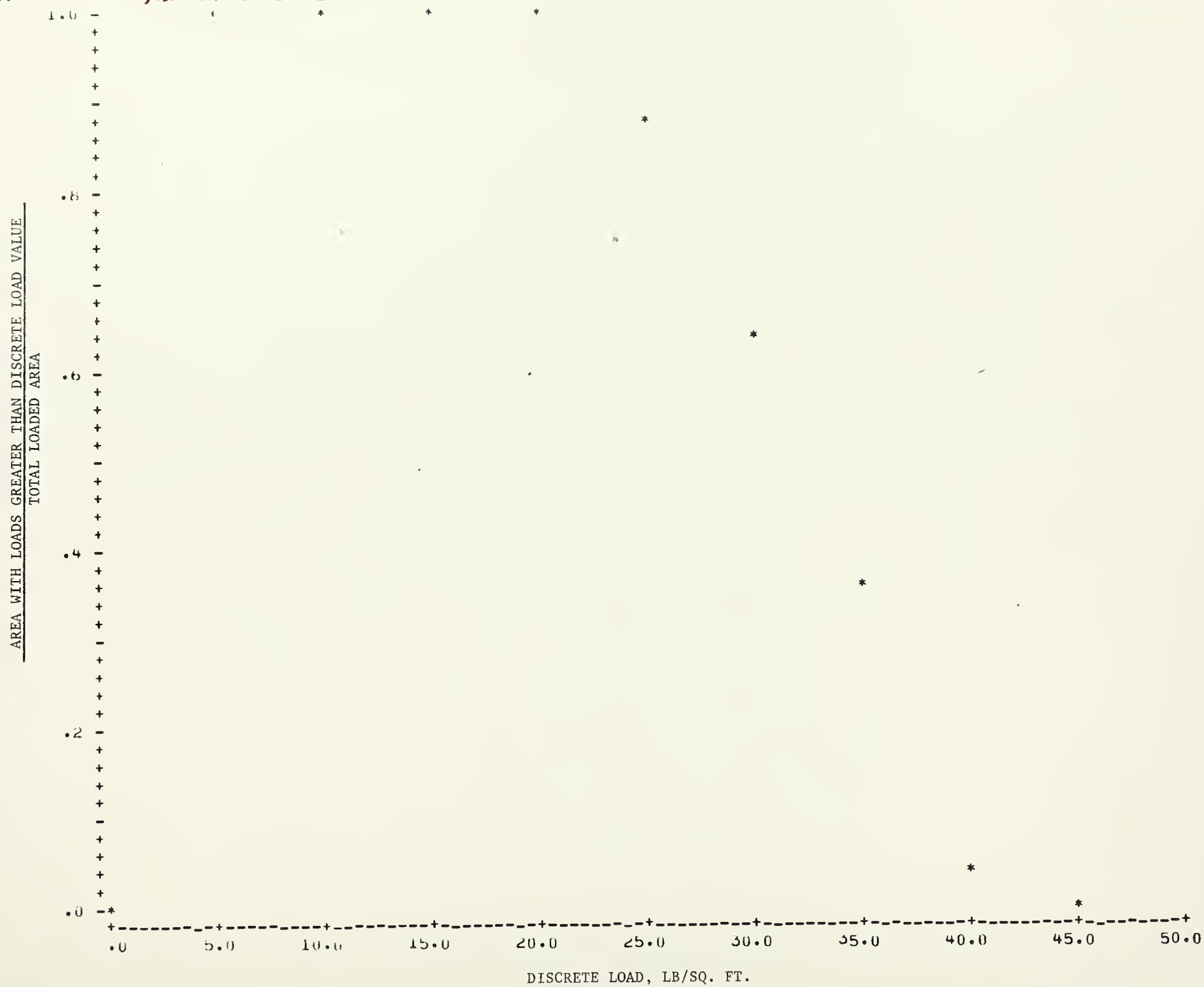

FIG. 31 - PLOT OF CUMULATIVE FRANCTIONS OF LOADED AREA CARRYING LOADS GREATER THAN A DISCRETE VALUE FOR WORK AREA 10.

CUMULATIVE FRACTIONS OF LOADED AREA CARRYING LOADS GREATER THAN A DISCRETE VALUE, WORK AREA, BUG.T.

TOTAL AREA= 86554.0 SQ.FT.

LOADED AREA= 19310.6 SQ.FT. = 22.3 % OF TOTAL AREA

ZERO LOAD= 67243.4 SQ.FT. = 77.7 % OF TOTAL AREA

U.D.L.= 6.5 FOR TOTAL AREA

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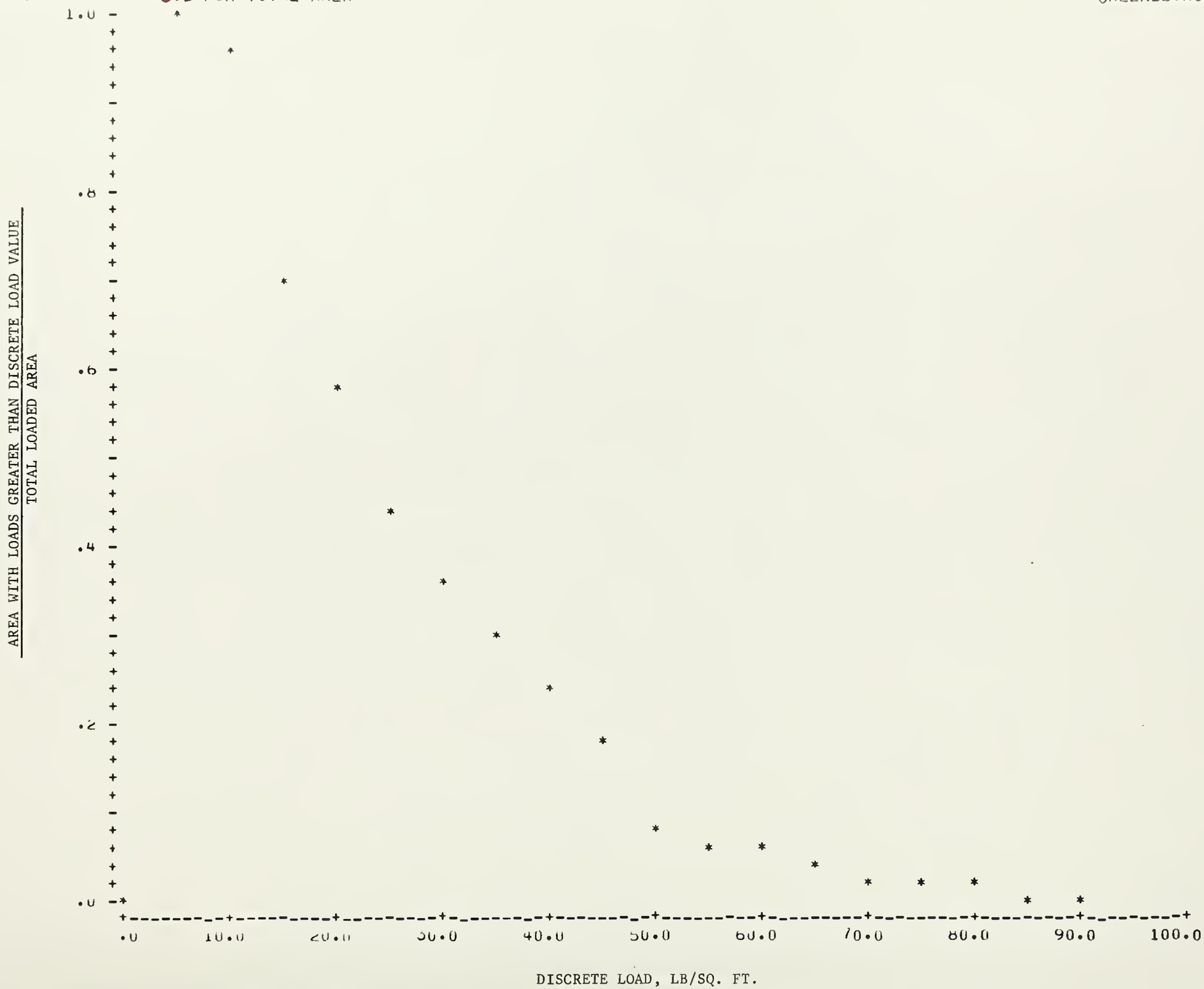

FIG. 32 - PLOT OF CUMULATIVE FRACTIONS OF LOADED AREA CARRYING LOADS GREATER THAN A DISCRETE VALUE FOR TOTAL WORKROOM AREA.

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