

L 2.3,
1441

Dayton & Montgomery Co.
Public Library

JUL 20 1965

DOCUMENT COLLECTION

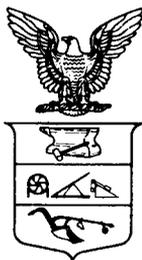
labor and material requirements for college housing construction

Bulletin No. 1441

UNITED STATES DEPARTMENT OF LABOR
W. Willard Wirtz, Secretary

BUREAU OF LABOR STATISTICS
Ewan Clague, Commissioner

labor and material requirements for college housing construction



Bulletin No. 1441
May 1965

UNITED STATES DEPARTMENT OF LABOR
W. Willard Wirtz, Secretary

BUREAU OF LABOR STATISTICS
Ewan Clague, Commissioner

For sale by the Superintendent of Documents, Government Printing Office
Washington, D.C., 20402 - Price 30 cents

Preface

This study of total labor and material requirements for the construction of college housing is the eighth in a series of studies of various types of construction that might be affected by future governmental action. Studies were published previously for schools, highways, Federal office buildings, hospitals, civil works activities of the Army Corps of Engineers, public housing, and private one-family dwelling units. Currently in progress are a study of sewage disposal facilities and a restudy of school construction requirements.

The studies are being conducted in the Bureau's Division of Productivity Measurement, Lloyd A. Prochnow, Chief, under the general direction of Leon Greenberg, Assistant Commissioner for Productivity and Technological Developments. This bulletin was prepared by Stanley F. Miller under the supervision of James F. Walker. Herman J. Rothberg was in charge of collecting and tabulating the statistical data.

The Bureau wishes to acknowledge the generous cooperation of the Housing and Home Finance Agency and its community Facilities Administration in furnishing some of the basic data used for this report. The Bureau also appreciates the cooperation of many general contractors and subcontractors who supplied the materials information on which estimates for indirect labor requirements are based.

CONTENTS

	Page
Introduction	1
Nature of the survey	2
General survey findings and characteristics	4
Project characteristics	6
Project costs	8
On-site man-hour requirements	10
Requirements by occupation	12
Apprentice man-hours	14
General and special trades contractors' man-hours	14
Cost of direct wages	18
Off-site employment	21
Builders' off-site employment	23
Employment in transportation, trade, and service	23
"Last manufacturing stage" employment	24
Employment in secondary activities	24
Construction time	24
Employment by construction periods	25
Materials used	25
Appendix. Scope and method of survey	32
Characteristics of the universe and selection of the sample	32
Man-hour estimates	32
Collection of on-site man-hour data	33
Off-site man-hours	33
Primary distribution industries employment	33
Primary manufacturing employment	34
Secondary employment in all industries	34
Total man-hour requirements	34
Tables:	
1. Number of college housing projects and average construction cost per square foot, by selected characteristics and region, 1960-61	9
2. On-site man-hour requirements for college housing projects, by selected characteristics and region, 1960-61	11
3. On-site man-hour requirements per \$1,000 of college housing construction contract, and percent distribution, by occupation and region, 1960-61	13
4. On-site man-hour requirements per \$1,000 of college housing construction contract, by proportion of lower skilled workers employed and region, 1960-61	15
5. Apprentice hours as a percent of total man-hours worked on college housing projects, by occupation and region, 1960-61	16

CONTENTS--Continued

	Page
 Tables--Continued	
6. Percent of total on-site man-hour requirements for college housing projects, by type of contractor and region, 1960-61	17
7. Average hourly on-site earnings and wages as a percent of construction cost for college housing projects, by selected characteristics and region, 1960-61	20
8. Man-hour requirements per \$1,000 of college housing construction contract, by producing sector and stage of manufacture, 1960-61	22
9. Cost of materials per \$1,000 of college housing construction contract, by type of material and region, 1960-61	28
 Charts:	
1. Distribution of 238 man-hours for each \$1,000 of college housing construction contract, 1960-61	5
2. Percent distribution of on-site wages and materials used for each \$1,000 of college housing construction contract, 1960-61	7
3. On-site man-hours for each \$1,000 of college housing construction contract, by decile of construction time, 1960-61	27

LABOR AND MATERIAL REQUIREMENTS FOR COLLEGE HOUSING CONSTRUCTION

Introduction

New construction is a major component of the Nation's output of goods and services and an important source of employment. Jobs are created not only at construction sites but also in many manufacturing, trade service, and transportation industries which make, sell, and deliver materials and equipment required in construction processes. Because of its far-reaching employment impact, a vigorous construction industry is regarded as a significant aid in avoiding cyclical unemployment.

To provide factual data on the employment generating effects of construction expenditures, the Bureau of Labor Statistics has a continuing program of studies to measure labor and material requirements for various segments of the construction industry. Construction of college housing was selected for study because this segment is one which could be significantly affected by governmental action.

Under the College Housing Loan Program, title IV of the Housing Act of 1950 (Public Law 81-485), approved April 20, 1950, and subsequently amended, long-term loans are made at low interest rates to finance the construction of dormitories, married student and faculty housing, dining halls, college unions, and infirmaries where such assistance is not otherwise available on equally favorable terms. The program was expanded in 1955 to include student unions, dining halls and similar service facilities. It was expanded again in 1957 to include loans to hospitals for housing student nurses, interns, and resident physicians.

The Housing and Home Finance Agency, in its 17th annual report, indicates that as of the end of 1963, applications for about 3,000 loans had been received from colleges and universities since the beginning of the program in 1950. The total loan requests amounted to more than \$3 billion. Of these, 1,992 had been approved and totaled \$2.1 billion. Three quarters of the eligible colleges and universities in the country have participated in the program and their enrollments account for more than 85 percent of the students in the eligible institutions.

Hospitals with nursing schools, interns, and resident physicians have filed a total of 174 loan applications in the amount of \$107.1 million. One hundred three of these have been approved for \$58.1 million.

During 1963, under the college housing loan program, 231 loans totaling \$275 million were completed providing living accommodations for almost 59,000 students and faculty members and 1,546 student nurses, interns, and resident doctors.

Nature of the Survey

This report is based on the findings in a survey of 43 college housing projects which were administered by the Community Facilities Administration (CFA). The projects were selected from a listing of 201 projects reported as being substantially completed during calendar year 1961. The projects selected were in various States representative of the four broad geographical regions of the conterminous United States.¹

The survey was designed primarily to determine man-hours required for a fixed-dollar volume (\$1,000) of college housing construction. Man-hours, as defined for the survey, include both on-site and off-site construction employment and off-site employment required to produce, sell, and deliver materials used in construction. Data for on-site labor include man-hours for supervisory, engineering, clerical, and custodial employees at construction sites and those for workers in the construction trades. Data were also obtained on wages paid and timing of employment. Information for off-site labor includes employment in activities of contractors such as office and warehousing; building materials and equipment manufacture and distribution; and finally employment in all other industries which are affected directly or indirectly by production and distribution of building materials, from raw materials to the final manufacturing stage.

Certain types of employment, however, are not covered by the survey. Man-hours expended on preparation of plans and specifications for projects are excluded, as is labor time involved in installations by public utility employees, site preparation, landscaping, and street and sewer work not included in the construction contracts.

¹ The States included in each of the regions are as follows: Northeast--Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont; North Central--Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota and Wisconsin; South--Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia; West--Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington and Wyoming.

Estimates were made of labor generated by money expended for contractors' overhead. The major portion of such overhead consists of administrative salaries. Employment for other overhead items, such as rent, bonds, insurance, taxes (including payroll taxes), fringe benefit payments, and office supplies, was estimated from secondary data. Employment created by the respending of wages and profits of workers and their employers--the multiplier effect--was not considered within the scope of this study.

General Survey Findings and Characteristics

Construction of college housing projects during 1960-61² created an estimated 238 man-hours of employment for each \$1,000 of construction contract cost. Employment at construction sites accounted for 94 man-hours, while 144 man-hours were required for various off-site activities. (See chart 1.) The latter included all employment required to produce and deliver materials and equipment installed by on-site workers, as well as employment required by construction contractors for administrative, warehousing, and certain other off-site operations. Off-site man-hours (except those for the construction industry) are developed from cost data relating to the value of materials used at construction sites (including rental costs or depreciation charges for construction equipment). Total man-hour requirements were distributed as follows:

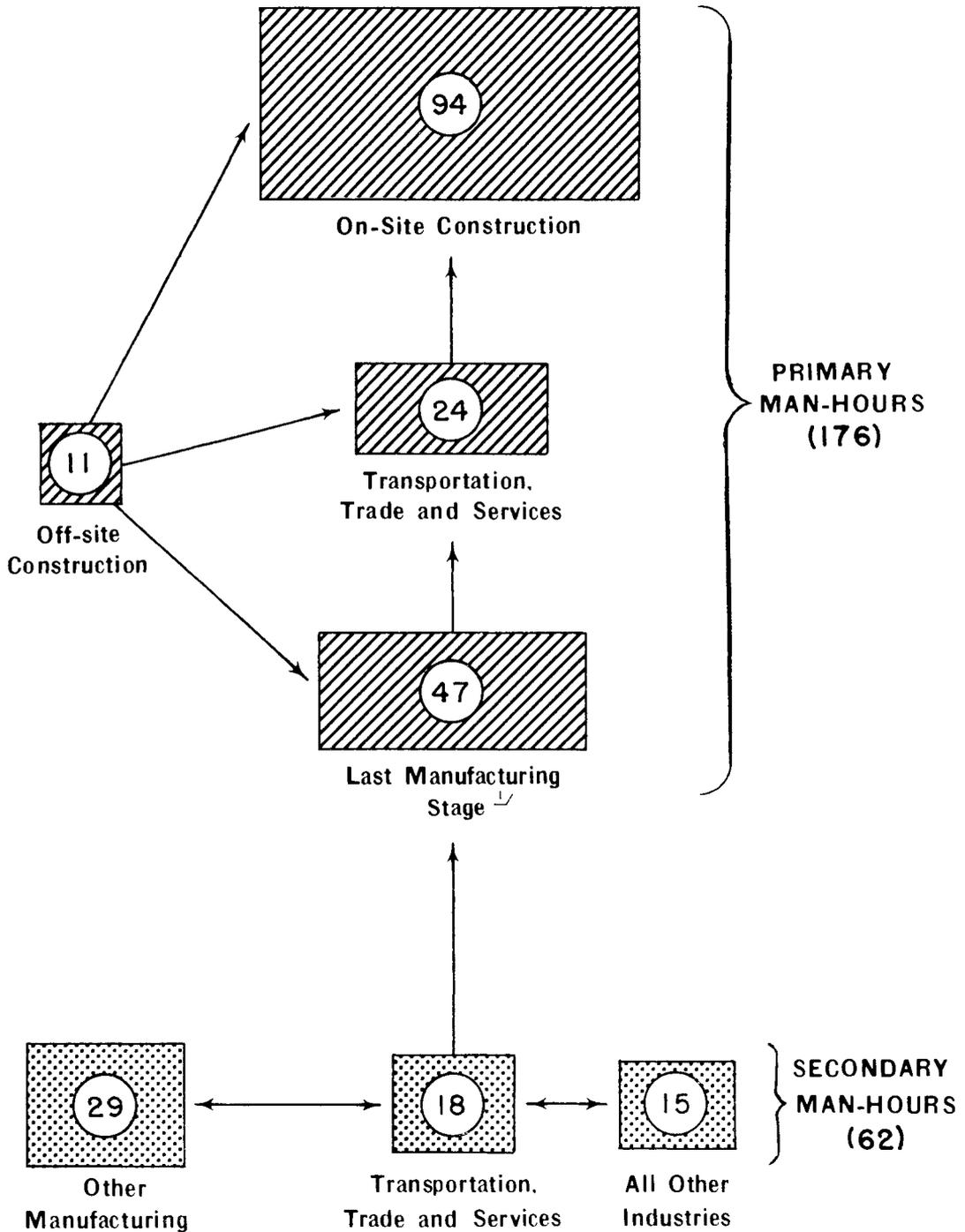
	Man-hours per \$1,000 of construction contract	
	Number	Percent
Total	238	100
On-site construction	94	39
Off-site	144	61
Construction	13	5
Manufacturing	73	31
Transportation, trade, and service ...	42	18
Other industries (including mining) ...	16	7

Length of construction time for the average project was 58 weeks, providing the equivalent of continuous work for about 46 workers (54 man-years) at construction sites. Off-site activities provided on average the equivalent of 1 year of employment for 74 workers.³

² Construction of the projects was accomplished over the period from late 1959 to early 1962, but the greater portion took place during 1960-61.

³ The annual employment estimate for construction workers is based on 50 times the 1961 average workweek of 36 hours for general building and special trade contractors, according to the Bureau's employment and earnings series. For other types of employment, 2,000 hours were considered as 1 year's employment.

Chart 1. Distribution of 238 Man-Hours for Each \$1,000 of College Housing Construction Contract, 1960-61



↳ Includes 3 man-hours in mining and other industries.

At the 1963 rate, construction of college housing has created about 14,000 jobs annually for on-site activities and approximately 20,000 for related off-site work. Current estimates indicate that college enrollments will total about 7 million students (100 percent increase) by 1975.

The study disclosed wide variations in man-hour and material requirements among projects, reflecting differences in type and size of projects, geographical locations, and local construction practices. Significant variations were noted in such related items as average hourly earnings and site wages as a percentage of construction cost. Material purchases amounted to about 54 percent of the construction expenditures, while wages for on-site man-hours were about 29 percent. (See chart 2.) Earnings for on-site labor averaged \$3.13 per hour (1960-61 data).

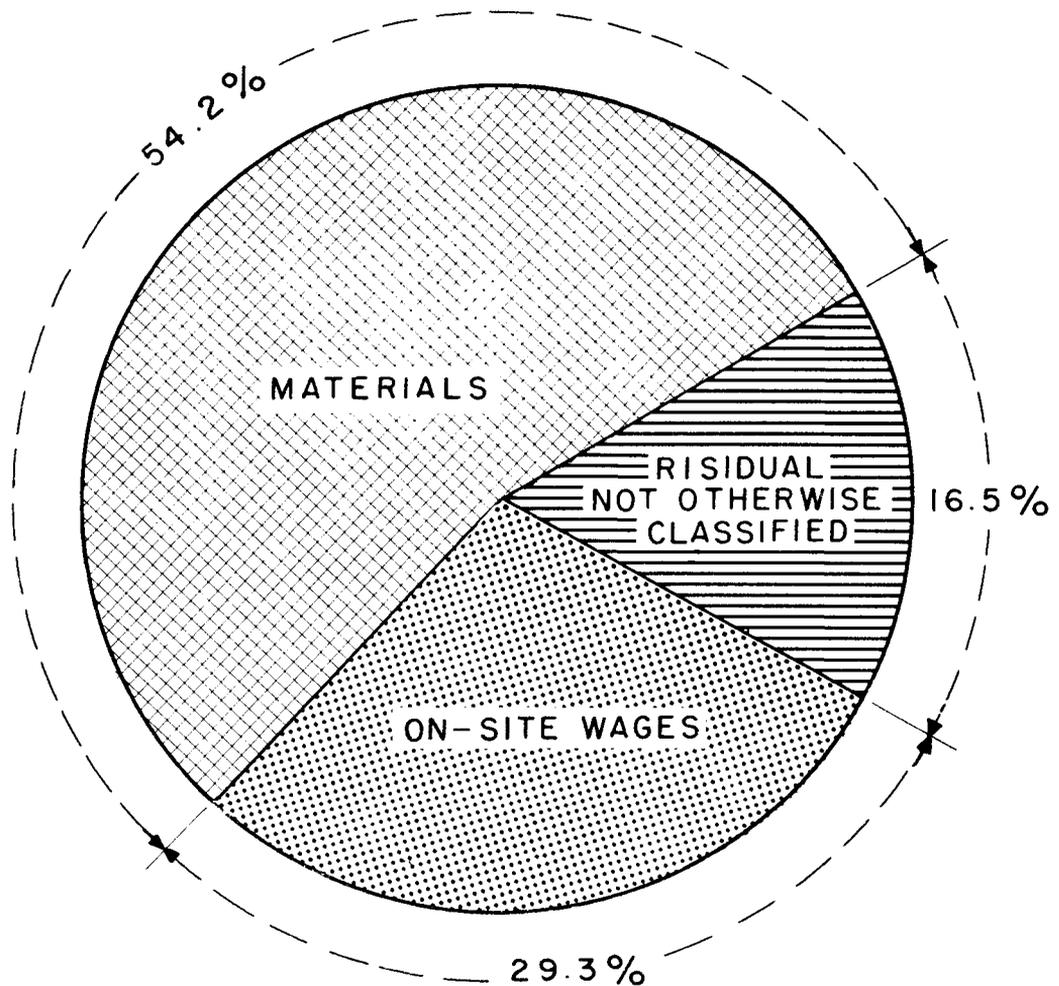
Project Characteristics

The 43 projects selected in the sample for this study varied in size from one with about 5,000 square feet to one containing 279,000 square feet; the average was about 66,000 square feet. Project construction costs (excluding site preparation and planning costs) ranged from about \$74,000 to almost \$4 million; the average was approximately \$1 million.

Almost 91 percent of the projects surveyed involved construction of buildings containing only living accommodations for students. The remainder were for projects containing dining facilities or student activity areas combined with living accommodations. Living accommodations for about 10,600 students were provided in 77 buildings--7 additional buildings provided only dining facilities or space for student activities. Locations of projects studied were divided almost equally between metropolitan and non-metropolitan areas; however, in the South almost three-fourths of the projects were in nonmetropolitan areas.

The projects studied were of three major structural frame types; reinforced concrete (63 percent), load-bearing masonry (16 percent), and steel (14 percent). The remaining 7 percent were a combination of reinforced concrete and steel. Each of the types has a slightly different division of man-hour and material requirements associated with its construction. All projects except one had primarily masonry exteriors--the one exception used curtain wall entirely for exterior facing. Almost three-fourths of the projects were constructed to provide partial or full basements. Projects were almost equally divided between those having elevators and those not having elevators. Bases for floors on all projects except one was constructed of concrete--covers for these floors were resilient tile in all except one project which used wood. About 70 percent of the projects were constructed with concrete roof decks. For about 90 percent of the projects studied, built-up roofing was used to cover decks.

Chart 2. Percent Distribution of On-Site Wages and Materials Used for Each \$1,000 of College Housing Construction Contract, 1960-61



UNITED STATES DEPARTMENT OF LABOR
BUREAU OF LABOR STATISTICS

Project Costs

Construction cost per square foot for all projects averaged \$15.88. However, wide differences were noted in construction costs per square foot among the individual projects in the survey and by region. For individual projects, costs per square foot ranged from about \$10 to almost \$28. Average cost per square foot in the Northeast region was 21 percent greater than the U.S. average.

Construction costs per square foot in all geographical regions were generally greater for projects constructed in metropolitan areas, and on-site man-hour requirements per \$1,000 of construction cost on these projects were below average.

Differences in cost per square foot between regions may result from interaction of several factors such as distance of projects from the sources of supply for various building materials, higher or lower wage costs, smaller or larger expenditures for such items as heating and insulating materials due to climatic differences. Costs are also influenced by the type of building constructed, which is reflected not only by the basic structural type, but by differences in design qualities and durability. Cost figures presented in this study pertain to construction costs only. Construction costs per square foot, by selected characteristics and by geographical region, are shown in table 1.

Table 1. Number of College Housing Projects and Average Construction Cost Per Square Foot, by Selected Characteristics and Region, 1960-61 ¹

Characteristic	United States		Northeast		North Central		South		West	
	Number	Average cost per square foot	Number	Average cost per square foot	Number	Average cost per square foot	Number	Average cost per square foot	Number	Average cost per square foot
All projects	43	\$15.88	10	\$19.18	11	\$15.86	14	\$14.08	8	\$14.69
Location:										
Metropolitan area	20	\$16.67	6	\$19.71	5	\$16.11	4	\$14.23	5	\$14.87
Nonmetropolitan area ...	23	14.91	4	17.78	6	15.38	10	14.01	3	14.46
Construction cost group:										
Less than \$1,000,000 ...	26	16.27	5	17.29	6	18.27	10	14.90	5	15.63
\$1,000,000 and over	17	15.71	5	19.85	5	15.09	4	13.54	3	14.43
With elevators	20	16.36	6	19.49	5	16.26	6	14.38	3	15.35
Without elevators	23	15.10	4	18.62	6	14.69	8	13.76	5	14.21

¹ Construction of the projects extended from late 1959 to early 1962, but the greater portion took place during 1960-61.

On-Site Man-Hour Requirements

On-site man-hour requirements varied from a low of about 75 man-hours to a high of approximately 140. The average for all projects was 93.6 (table 2) per \$1,000 of contract cost.

Owing to the limited number of projects selected for the sample, it was impractical to make an analysis and arrive at definite conclusions relative to the wide differences in requirements observed for most of the various project characteristics. However, there does appear to be a definite relationship between man-hour requirements and the size and/or location of projects.

A significant difference was noted in the greater average number of man-hours required for projects located in the South. Requirements in this region were reported at one-fifth greater than the national average and almost one-third greater than the average for the West. In some cases, the greater man-hour requirements were probably due to the size and location of projects in this region. Almost three-fourths of the 14 projects in the South had a contract construction cost below the national average of \$1 million. Seventy-one percent of the projects in the South were constructed in nonmetropolitan areas.

Indications from other construction labor requirements studies made by the Bureau are that smaller projects constructed in nonmetropolitan areas tend to require more on-site man-hours per \$1,000 of construction cost than do larger projects constructed in metropolitan areas. Generally, small projects constructed in nonmetropolitan areas present less opportunity to utilize laborsaving equipment and procedures. There is a greater tendency to use lower skilled workers at low wage rates in place of such equipment and procedures. This tendency is in part borne out by the fact that in metropolitan areas, 63 percent of the projects studied required less than the average number of on-site man-hours per \$1,000 of construction cost, and almost 75 percent of the projects reported higher than average hourly earnings. Conversely, in nonmetropolitan areas where 62 percent of the projects required more than the average number of man-hours, average hourly earnings were lower for about 60 percent of the projects studied.

Comparison of man-hour requirements for projects with elevators and those without elevators reveals that those without elevators required considerably more man-hours per \$1,000 of construction cost. Analysis of these requirements reveals, again, that size and location of projects are more than likely to be the dominant factors rather than the inclusion or exclusion of elevators.

Table 2. On-Site Man-Hour Requirements for College Housing Projects,
by Selected Characteristics and Region, 1960-61¹

Characteristic	United States		Northeast		North Central		South		West	
	On-site man-hours per--									
	\$1,000 of cost	1,000 square feet	\$1,000 of cost	1,000 square feet	\$1,000 of cost	1,000 square feet	\$1,000 of cost	1,000 square feet	\$1,000 of cost	1,000 square feet
All projects	93.6	1,486	85.0	1,630	86.9	1,378	111.5	1,571	84.3	1,239
Location:										
Metropolitan area	86.8	1,447	85.0	1,676	83.4	1,344	98.8	1,407	84.0	1,249
Nonmetropolitan area ...	102.9	1,534	85.0	1,512	93.9	1,444	117.9	1,651	84.8	1,226
Construction cost group:										
Less than \$1,000,000 ...	103.3	1,682	84.7	1,465	104.5	1,909	114.7	1,710	91.4	1,429
\$1,000,000 and over	89.3	1,403	85.1	1,690	80.1	1,209	109.2	1,478	82.2	1,185
With elevators	88.7	1,451	86.2	1,681	82.6	1,344	101.0	1,447	82.1	1,261
Without elevators	102.3	1,544	82.7	1,540	100.7	1,479	125.8	1,731	86.1	1,223

¹ Construction of the projects extended from late 1959 to early 1962, but the greater portion took place during 1960-61.

Man-hour requirements were the highest for projects constructed with load-bearing masonry framing; reinforced concrete structures required the next highest number of man-hours. Structures using steel for framing required the third highest number of man-hours. Three projects studied used a combination of steel and reinforced concrete and reported the least number of man-hours per \$1,000 of construction cost. It is not clear, however, whether the variations are due to structural differences or if sizes and locations of the projects are the main contributing factors. Project construction costs were greater than average for those using a combination of framing materials. All projects (six) constructed with steel framing indicated costs below average and all except one of these projects were located in nonmetropolitan areas. Reinforced concrete was used in construction of 50 percent of the projects located in nonmetropolitan areas and for almost four-fifths of those in metropolitan areas. Owing to insufficient data for some types of construction in all regions, comparisons are not presented by region; however, the following tabulation presents data pertaining to the total projects surveyed:

Type of structural framing	Number of projects	Man-hours per \$1,000 of cost	Cost per square foot
All projects	43	93.6	\$15.88
Reinforced concrete	27	96.9	16.08
Load-bearing masonry ..	7	102.0	15.47
Steel	6	92.2	17.53
Combination (steel and reinforced concrete) ...	3	77.1	14.88

Requirements by Occupation

Regional variations in man-hour requirements for different occupations (table 3) reflect differences in design, work practices, and wage rates. The greatest variations are noted in the division between skilled and unskilled occupations. For purposes of this study, laborers, helpers, and tenders were classified as lower skilled workers. In the South, over 40 percent of the on-site man-hour requirements were accounted for by these lower skilled workers, whereas, in the other regions, the range was from about 25 to 30 percent.

Regional variations within the skilled occupations are related most directly to differences in structural types. Distinctive differences are noted for those projects using reinforced concrete for structural framing. Man-hour requirements on these projects are high for lathers, ironworkers, and plumbers, but low for carpenters and painters. Man-hour requirements, of course, are high for bricklayers on those projects constructed with load-bearing masonry.

Table 3. On-Site Man-Hour Requirements per \$1,000 of College Housing Construction Contract, and Percent Distribution, by Occupation and Region, 1960-61¹

Occupation	United States		Northeast		North Central		South		West	
	Man-hours worked	Percent	Man-hours worked	Percent	Man-hours worked	Percent	Man-hours worked	Percent	Man-hours worked	Percent
All occupations	93.6	100.0	85.0	100.0	86.9	100.0	111.5	100.0	84.3	100.0
General supervisors	2.4	2.6	2.1	2.5	2.2	2.5	3.0	2.6	2.2	2.6
Professional, technical, and clerical ...	.8	.8	1.1	1.3	.9	1.0	.7	.6	(2/)	(2/)
Carpenters	15.8	16.9	15.2	17.9	12.8	14.7	17.2	15.5	21.3	25.3
Bricklayers	9.4	10.0	9.8	11.5	9.5	10.9	10.5	9.4	4.9	5.9
Plumbers	9.1	9.7	9.4	11.1	9.0	10.3	9.2	8.3	8.6	10.1
Electricians	6.2	6.6	7.1	8.3	6.0	6.9	6.0	5.4	5.2	6.2
Ironworkers	3.6	3.9	4.3	5.1	3.9	4.5	2.9	2.6	3.1	3.6
Reinforcing	2.2	2.4	2.8	3.3	2.2	2.5	2.0	1.8	1.6	1.9
Structural .....	.7	.8	.4	.5	.7	.8	.8	.7	1.2	1.5
Ornamental .....	.7	.7	1.1	1.3	1.1	1.2	(2/)	(2/)	.2	.3
Painters	3.3	3.6	3.0	3.5	2.9	3.4	3.5	3.1	5.0	5.9
Cement finishers	1.7	1.9	1.6	1.9	1.4	1.6	2.1	1.9	2.0	2.4
Plasterers	1.7	1.8	.6	.7	2.4	2.8	2.3	2.0	1.3	1.5
Operating engineers	1.6	1.7	1.5	1.7	1.4	1.6	1.6	1.5	1.9	2.2
Lathers	1.5	1.6	.7	.9	2.1	2.4	1.6	1.4	1.3	1.5
Sheet-metal workers	1.4	1.5	2.0	2.4	1.5	1.8	.7	.6	1.3	1.6
Tile setters and terrazzo workers	1.2	1.3	1.4	1.6	1.2	1.4	1.4	1.3	.6	.7
Asbestos workers .....	.8	.8	.7	.7	1.0	1.2	.6	.5	.7	.9
Roofers .....	.7	.8	.7	.9	.9	1.0	.6	.6	.6	.8
Soft floor layers .....	.6	.6	.6	.7	.6	.7	.4	.4	.9	1.1
Glaziers .....	.5	.5	.5	.6	.4	.5	.6	.5	.5	.6
Elevator mechanics .....	.3	.4	.3	.4	.3	.4	.4	.4	.2	.2
Laborers ³	24.2	25.8	17.1	20.1	20.6	23.8	37.0	33.2	16.4	19.4
Helpers and tenders ³	5.6	6.0	4.1	4.8	5.0	5.7	8.1	7.3	4.5	5.3
Truckdrivers .....	.5	.5	.3	.4	.5	.5	.6	.5	1.0	1.2
Watchmen .....	.3	.3	.5	.6	.1	.1	.3	.2	.2	.3
Other .....	.3	.3	.3	.4	.3	.3	.3	.2	.6	.7

¹ Construction of the projects extended from late 1959 to early 1962, but the greater portion took place during 1960-61.

² Less than 0.05 percent.

³ Laborers, helpers, and tenders are considered as lower skilled.

Note: Because of rounding, sums of individual items may not add to totals.

The relative proportions of lower skilled workers employed, as shown in table 4, depends partly on the type of structure, on the level of wages, and on work practices. Low wage rates make it more economical to use greater quantities of such workers. If wage rates are high, there is a greater incentive to substitute laborsaving equipment and techniques for lower skilled workers. There is much less possibility of replacing skilled workers by such equipment and techniques even if wage rates are quite high. The present nature of building construction is such that mechanization cannot be carried as far as in most other industries.

Apprentice Man-Hours

Apprentices in formal, registered apprenticeship programs⁵ accounted for 4.7 percent of total on-site man-hours and 7.3 percent of skilled man-hours (table 5). Apprentice electricians, sheet-metal workers, and plumbers accounted for a greater proportion of skilled man-hours for their craft than all others--18.3, 16.8, and 12.5, respectively. Apprentice man-hours were relatively high for these occupations in all regions. Formal apprenticeship training programs do not exist or are just evolving for three occupations--asbestos workers, elevator mechanics, and operating engineers. Training in these occupations is usually accomplished on an informal basis through assisting a journeyman in his work until the trainee is considered fully qualified to perform at the journeyman level of proficiency. In some instances, predetermined time periods of on-the-job training are required to be eligible for upgrading to journeyman status. This criteria has usually been informally established through local work practices. Workers in a learning status, whether designated as "improvers" in the case of asbestos workers, "helpers" in elevator installation, or "oilers" in construction equipment operation, were grouped with helpers and tenders for this report. High rates of apprentice man-hours are usually associated with some smaller crafts or with those crafts where there is a shortage of skilled journeymen.

General and Special Trades Contractors' Man-Hours

Employees of general contractors accounted for almost 50 percent of all on-site man-hours worked on college housing projects surveyed (table 6). This ratio was somewhat lower in the Northeast and North Central regions and higher for the South and West. A greater percentage of

⁵ A bona fide apprenticeship program registered with a State Apprenticeship Council which is recognized by the Federal Committee on Apprenticeship, U. S. Department of Labor, or a program registered with the Bureau of Apprenticeship and Training, U. S. Department of Labor.

Table 4. On-Site Man-Hour Requirements per \$1,000 of College Housing Construction Contract, by Proportion of Lower Skilled Workers Employed ¹ and Region, 1960-61 ²

Percent of total workers lower skilled	Man-hours per \$1,000 of contract				
	United States	Northeast	North Central	South	West
All workers	93.6	85.0	86.9	111.5	84.3
25.0 and under	83.3	84.4	79.9	87.9	83.5
25.1-35.0	88.4	85.4	86.8	112.2	85.2
35.1 and over	112.4	--	104.6	113.2	--

¹ For purposes of this comparison, laborers, helpers, and tenders were classified as lower skilled.

² Construction of the projects extended from late 1959 to early 1962, but the greater portion took place during 1960-61.

Table 5. Apprentice Hours as a Percent of Total Man-Hours Worked on College Housing Projects, by Occupation and Region, 1960-61¹

Occupation	United States	Northeast	North Central	South	West
All workers	4.7	4.7	4.0	4.7	6.4
Skilled trades only	7.3	6.7	6.0	8.4	9.0
Bricklayers	5.3	5.4	3.3	6.6	8.1
Carpenters	4.4	2.9	5.4	3.6	7.2
Cement finishers	2.3	6.4	(2/)	--	5.0
Electricians	18.3	14.9	14.8	23.6	24.4
Glaziers	6.7	11.7	--	1.9	22.0
Ironworkers	3.5	1.6	2.0	7.5	5.0
Ornamental	5.5	5.4	6.1	3.4	.9
Reinforcing .....	.9	(2/)	.4	1.0	5.8
Structural	9.7	1.8	.8	23.3	4.7
Lathers	7.1	6.6	8.0	6.4	6.2
Painters	4.5	2.7	5.1	6.1	3.1
Plasterers	2.1	2.5	2.7	1.2	2.6
Plumbers	12.5	10.5	9.5	16.5	14.6
Roofers	8.8	1.7	13.0	13.2	1.3
Sheet-metal workers	16.8	27.3	2.9	20.0	14.4
Soft-floor layers	5.9	8.5	6.4	2.2	5.8
Tile setters and terrazzo workers	6.2	.8	5.9	11.2	6.8

¹ Construction of the projects extended from late 1959 to early 1962, but the greater portion took place during 1960-61.

² Less than 0.05 percent.

Table 6. Percent of Total On-Site Man-Hour Requirements for College Housing Projects, by Type of Contractor and Region, 1960-61 ¹

Type of contractor	United States	Northeast	North Central	South	West
All types	100.0	100.0	100.0	100.0	100.0
General	49.4	47.2	42.1	56.2	50.4
Special trades	50.6	52.8	57.9	43.8	49.6
Plumbing and heating	14.5	14.2	15.2	14.4	13.5
Electrical	7.0	8.4	6.9	6.1	6.4
Masonry	6.6	7.4	9.7	3.5	7.5
Plastering and lathing	4.9	2.0	7.6	5.0	4.1
Painting	3.4	3.6	3.4	3.1	4.0
Tile and terrazzo work	3.0	3.7	3.0	2.9	1.3
Structural and ornamental ironwork	2.7	4.3	3.0	1.9	1.9
Roofing and sheet metal	1.4	1.6	1.4	1.2	1.5
Site preparation and excavation	1.2	1.6	1.4	1.0	.5
All other types	5.9	6.0	6.3	4.7	8.9

¹ Construction of projects extended from late 1959 to early 1962, but the greater portion took place during 1960-61.

the projects in the latter two regions reported construction costs lower than the average for the United States. The smaller project size found in the majority of South and West projects, usually entailed more activity by the general contractor, because for many building trades, there was insufficient work to necessitate the issuing of subcontracts. Plumbing and heating, electrical, and masonry were the three special trades groups showing the greatest percentage of total man-hour requirements--about 28 percent. Man-hours reported for these three special trades accounted for over 55 percent of all man-hours reported by special trade subcontractors. The average number of subcontractors employed per project is shown in the following tabulation:

	Average number of subcontractors per college housing project		
	All projects	Project cost less than \$1,000,000	Project cost \$1,000,000 or over
United States	23	20	28
Northeast	26	19	32
North Central	24	19	32
South	19	20	18
West	22	21	26

Cost of Direct Wages⁶

Wage payments for on-site man-hours averaged 29.3 percent of construction contract cost for all college housing projects studies. The ratio of wage payments to construction cost was remarkably constant when regional differences are considered; however, a wide variation was noted between individual projects, where the ratio ranged from a low of about 20 percent to a high of about 37 percent. Even with these wide differences noted for individual projects, almost two-thirds of all projects ranged between 26 percent and 32 percent. The constancy of this ratio indicates that high man-hour requirements are associated with low wage rates and vice versa. Indications are that construction techniques are adapted to regional differences in labor conditions through greater or lesser utilization of mechanized equipment.

⁶ Excluded are payments for vacation and holiday pay and other labor costs such as employer contributions to social security, unemployment insurance, workmen's compensation, and nongovernmental employee welfare and pension funds. Included are wages for all hours worked and overtime wages.

Table 7 shows average hourly earnings and total wages for on-site employment as a percent of construction cost. Average hourly earnings for projects constructed in the South were considerably lower than for projects in other regions. There are three significant reasons for this lower average: (1) Wage rates are generally lower in the South than in other regions, especially for lower skilled workers; (2) a larger percent of on-site labor in the South is lower skilled; and (3) in all regions, wage rates tend to be lower in nonmetropolitan areas, and the greater portion of projects constructed in the South were located in nonmetropolitan areas, while the majority of the projects in other regions were located in metropolitan areas.

Table 7. Average Hourly On-Site Earnings and Wages as a Percent of Construction Cost for College Housing Projects, by Selected Characteristics and Region, 1960-61¹

Characteristic	United States		Northeast		North Central		South		West	
	Average hourly earnings	Wages as percent of construction cost	Average hourly earnings	Wages as percent of construction cost	Average hourly earnings	Wages as percent of construction cost	Average hourly earnings	Wages as percent of construction cost	Average hourly earnings	Wages as percent of construction cost
All projects	\$ 3.13	29.3	\$ 3.63	30.8	\$ 3.45	30.0	\$ 2.51	28.0	\$ 3.28	27.7
Location:										
Metropolitan area	\$ 3.45	30.0	\$ 3.77	32.1	\$ 3.56	29.7	\$ 2.78	27.5	\$ 3.33	28.0
Nonmetropolitan area ...	2.77	28.5	3.21	27.3	3.25	30.5	2.39	28.2	3.21	27.2
Construction cost group:										
Less than \$1,000,000 ...	2.99	30.9	3.81	32.2	3.07	32.1	2.56	29.4	3.44	31.4
\$1,000,000 and over	3.21	28.6	3.57	30.4	3.64	29.2	2.47	26.9	3.23	26.5
With elevators	3.28	29.1	3.54	30.5	3.60	29.7	2.73	27.6	3.27	26.8
Without elevators	2.90	29.7	3.80	31.4	3.06	30.8	2.26	28.5	3.29	28.3

¹ Construction of the projects extended from late 1959 to early 1962, but the greater portion took place during 1960-61.

Off-Site Employment

For each 94 man-hours of employment performed at construction sites of college housing projects, 144 additional man-hours were required to produce and distribute necessary construction materials, supplies, and equipment. Thus, a total of 238 man-hours were generated for each \$1,000 expended for construction contract costs.

Off-site employment is generated in many places but can be classified in the following categories:

1. Construction industry--off-site; administrative, estimating, clerical, and warehousing activities.
2. Manufacturing activities required to produce fabricated products, raw materials, and equipment.
3. Transportation, warehousing, and distribution of fabricated products, raw materials, and equipment.
4. All other industries directly or indirectly affected by production of fabricated products, raw materials, and equipment. Various inter-industry transactions eventually affect all additional industries such as agriculture, forestry, and mining.

There are other types of employment affected by construction activities which this study did not attempt to estimate: Employees of architectural firms, utility companies, and State and local governments. These employees and their functions were not generally included in construction contract costs. A large area of employment, also excluded from calculations of man-hours requirements, is that created by respending and investing of wages and profits arising in various areas of economic activity within the scope of this study.

Although the ratio of on-site to off-site man-hour requirements is commonly used in analyzing employment requirements in the construction industry, another type of distinction based upon the economic relations of labor-generating areas is also useful. Therefore, employment requirements have also been divided into primary and secondary man-hour needs. As shown in table 8, primary man-hour requirements per \$1,000 of construction cost, estimated at 175.6, are in activities at the site, and those most directly related to construction activity. Included in these, in addition to site employment, are off-site construction employment, employees of manufacturing industries represented at the "last stage of manufacturing" for materials prior to shipments to construction sites, employees in transportation, trade and service, and other industries including mining.

Table 8. Man-Hour Requirements Per \$1,000 of College Housing Construction Contract, by Producing Sector and Stage of Manufacture, 1960-61

Sector	Total man-hours	Primary man-hours	Secondary man-hours
All sectors	237.6	175.6	61.9
On-site construction	93.6	93.6	--
Other construction	12.7	11.2	1.5
Agriculture, forestry, and fisheries..	3.6	.1	3.5
Mining	3.4	.4	3.0
Manufacturing	72.5	43.7	28.8
Lumber and lumber products	7.9	4.8	3.1
Furniture	1.8	1.6	.2
Paper and paper products	1.7	.2	1.5
Printing	1.2	--	1.2
Chemicals	1.8	.2	1.5
Stone, clay, and glass products	15.6	13.0	2.6
Primary metals	10.0	2.6	7.4
Fabricated metal products	16.9	13.7	3.1
Machinery	5.8	3.2	2.7
Electrical products	5.3	3.3	2.0
Other manufacturing	4.7	1.3	3.4
Transportation	9.6	3.9	5.7
Wholesale trade	25.4	18.3	7.2
Services	7.2	1.6	5.7
Other industries	9.4	2.8	6.6

Note: Because of rounding, sums of individual items may not add to totals.

Secondary man-hour requirements have been defined as those associated with all other requirements related indirectly to needs at the sites. Such activities, totaling 61.9 man-hours or about 26 percent of total man-hour requirements, affect all parts of the economy as the impact of primary activity is reflected in demand for basic materials and related transportation, trade, and services.⁷

Some industries are represented in both primary and secondary sectors. For example, the sand and gravel industry furnishes material directly to the construction industry and also to the ready-mixed concrete industry, which in turn sells to the construction industry.

Builders' Off-Site Employment

An exact study of off-site employment of each contractor was not attempted, since it was almost impossible to relate accurately such employment to projects being studied. Builders' off-site employment was occupied not only with projects studied, but also with other current or future projects.

The estimate of 11.2 off-site man-hours for each \$1,000 of construction contract is based on the difference between construction worker employment and total employment in the construction industry.⁸ This estimate also includes unreported hours for a few self-employed craftsmen who may have worked at construction sites.

Combining this employment with on-site employment results in an estimate of 104.8 man-hours of employment in the construction industry for each \$1,000 of college housing construction.

Employment in Transportation, Trade, and Service

Distribution of construction materials from producing industries requires employment of workers in transportation, trade and service industries. The estimate of 23.8 man-hours of primary employment per \$1,000 of construction contract is based on the difference between producer's value

⁷ Secondary man-hours were estimated on the basis of a study made by the Office of Business Economics of 1958 interindustry relationships. See M. R. Goldman, M. L. Marimont, and B. N. Vaccard, "The Interindustry Structure of the United States," Survey of Current Business (November 1964), Washington, D. C., pp. 10-29. For methods employed, see appendix.

⁸ Administrative, engineering, estimating, and clerical workers accounted for about 14 percent of total employment in the construction industry. About one-fourth of this employment was involved at construction sites. Employment and Earnings Statistics for the United States, 1909-64 (BLS Bulletin 1312-2, 1964).

and delivered value of materials used at construction sites. This estimate includes only distribution of materials from producers to construction sites and excludes distribution of materials among industries prior to shipment of completed products.

"Last Manufacturing Stage" Employment

Manufacturing is the sector of the economy most affected, other than the construction industry, by construction of college housing. It is estimated that 44 primary man-hours were required for each \$1,000 of total construction contract to produce materials used in the construction of college housing projects. This estimate, however, includes only employment required in the last manufacturing process of materials.⁹ Employment generated by this activity is distributed in many industries affected directly by construction activity. For example, it includes sawmills cutting rough lumber for forms, and establishments making millwork items from lumber, but does not include employment in sawmills producing lumber for millwork products. The latter is included in estimates of secondary employment discussed in the following paragraph. Agriculture, mining and other industries required the remaining 3 primary hours.

Employment in Secondary Activities

In addition to 44 man-hours previously noted for primary employment for each \$1,000 of construction contract in factories producing construction materials, an additional 29 man-hours were required in secondary manufacturing activities.

Transportation, trade and service industries as a group required 18 man-hours for each \$1,000 of construction contract to meet the needs of secondary business activity.

Other business activities, principally agriculture, forestry, mining, and other construction, accounted for the remaining 15 man-hours of secondary requirements.

Construction Time

Average construction time for college housing projects surveyed was 58 weeks. Individual projects ranged from a low of 18 weeks to a high of 96 weeks. For projects costing less than \$1 million, the average construction time was 50 weeks, while those in the \$1 million and over cost class required an average of 71 weeks. Construction time for projects in

⁹ Included in the bill of materials were supplies and the depreciated or rental value of construction equipment used by contractors.

the South and West was generally lower than for comparable projects in other regions. Milder climate, permitting almost year-round construction activity, was probably the cause in most cases for this lower time requirement. Average number of weeks of construction is presented in the following tabulation by cost class:

Average number of weeks of construction time

	United States	North- east	North Central	South	West
Total	58	63	62	54	51
Under \$1,000,000	50	50	59	48	39
\$1,000,000 and over ...	71	74	68	71	71

Employment by Construction Periods

In order to measure the distribution of employment, the construction time for each project was divided into 10 equal periods. Data on the number of man-hours worked were tabulated for each of these periods. This permitted the combination of man-hours for projects requiring different numbers of weeks of work in order to obtain typical employment patterns. The typical pattern is for employment to start slowly, build to a peak in the middle period, and then taper off towards the end of construction. There were no radical departures from this pattern. Chart 3 shows on-site man-hour requirements per \$1,000 of construction cost by decile. The percent of total man-hours for all projects by decile, were as follows:

1st	3.4	6th	16.1
2nd	7.0	7th	14.9
3rd	9.7	8th	11.4
4th	11.5	9th	8.1
5th	14.1	10th	3.7

Materials Used

Expenditures for materials used in the construction of college housing projects studied amounted to about \$542 (54.2 percent) of each \$1,000 of construction contract cost (table 9). These expenditures included depreciation charges or rental costs for construction equipment used, as well as costs for supplies consumed and materials or fixed equipment incorporated in the structures. Expenditures ranged from \$444 to \$672 per project. The percent of projects reporting expenditures for materials per \$1,000 of construction cost falling within selected ranges appears in the following tabulation.

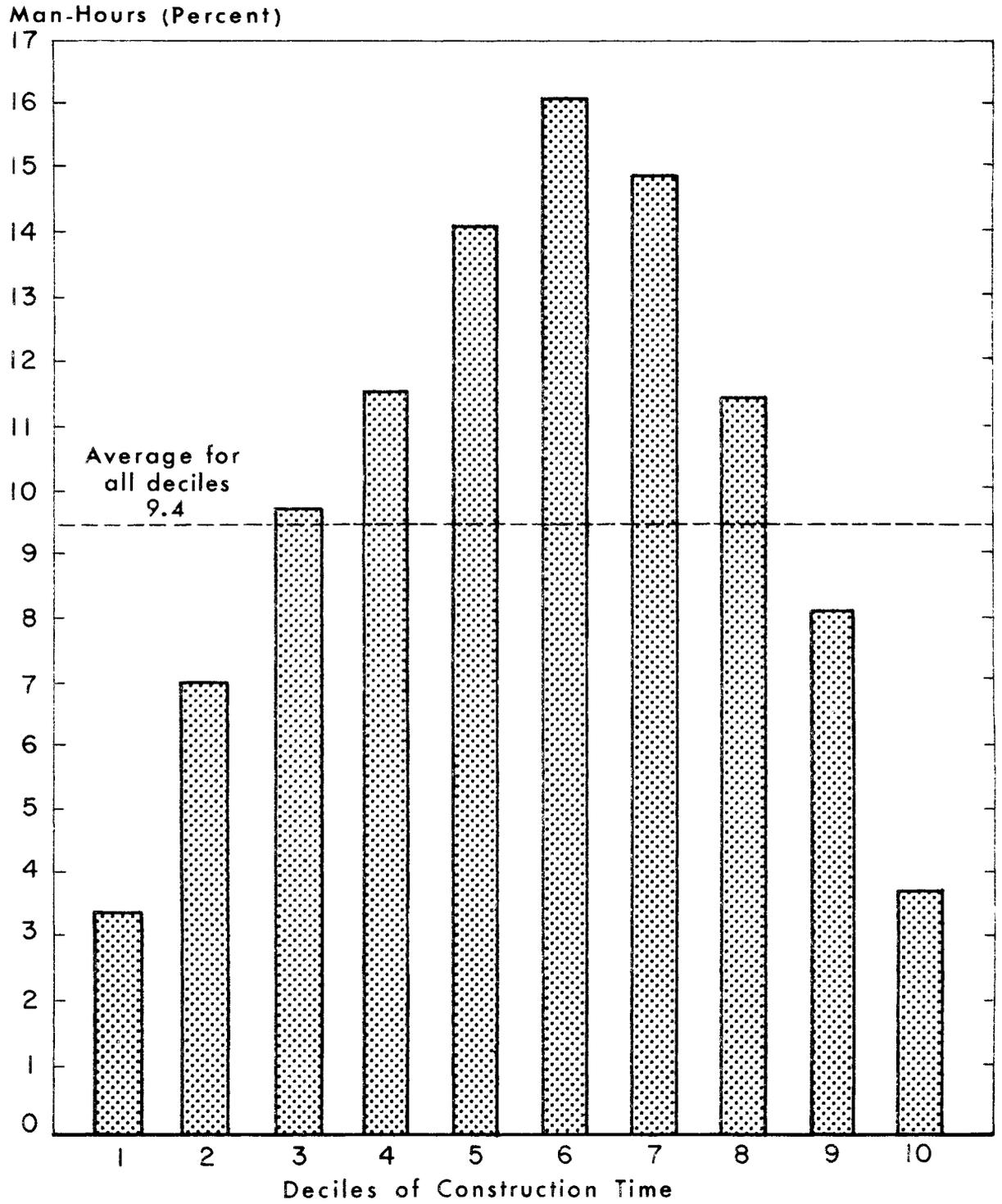
<u>Percent expenditures for materials were of total construction costs</u>	<u>Percent of projects</u>
Under 50.0	25.6
50.0 to 54.9	37.2
55.0 to 59.9	20.9
60.0 and over	16.3

Total expenditures for the major materials groups presented for four broad geographical regions indicate that there was no great difference between regions; however, for some of the items listed in the major materials groupings, there were wide differences.

Major types of materials used include metal products (excluding plumbing and heating) which represented 28 percent of the total; stone, clay, and glass products, about 27 percent; lumber and lumber products, almost 11 percent; and electrical equipment, including fixtures and wire, and plumbing products, each representing about 8 percent. Total expenditures for materials in these five major groupings amounted to approximately four-fifths of the total material expenditures in all regions.

Differences in the amounts expended for the components making up group totals were quite noticeable in some instances and were due generally to the different structural types, location, and size of projects.

Chart 3. On-Site Man-Hours for Each \$1,000 of College Housing Construction Contract, by Decile of Construction Time, 1960-61



UNITED STATES DEPARTMENT OF LABOR
BUREAU OF LABOR STATISTICS

Table 9. Cost of Materials per \$1,000 of College Housing Construction Contract,
by Type of Material and Region, 1960-61¹

Selected products and product groups	United States	North-east	North Central	South	West
Total cost, all products	\$541.60	\$524.70	\$526.90	\$573.00	\$536.40
Metal products (except plumbing and heating)	\$151.90	\$146.90	\$144.50	\$165.50	\$147.40
Fabricated metal products	137.30	133.90	136.60	143.00	133.40
Reinforcing bars, rods, and joists	36.60	34.60	25.30	33.80	45.50
Structural steel	23.90	27.70	24.20	16.70	32.80
Metal windows, frames, and accessories	20.80	28.30	19.40	19.10	10.70
Sheet-metal products	17.90	16.00	21.20	18.50	13.00
Builder's hardware	12.50	10.40	13.60	14.10	10.10
Metal doors, frames, and accessories	8.80	5.90	10.20	10.00	8.90
Ornamental metal	8.00	5.90	12.00	7.10	5.50
Metal lath	2.60	2.10	3.50	2.20	2.60
Metal lockers, partitions, and shelves	1.90	1.80	1.60	2.40	1.80
Wire mesh	1.80	.80	2.60	2.30	1.40
Curtain walls	1.40	--	2.30	14.80	--
Shower and bathroom accessories .....	.60	.10	.40	.90	1.10
Metal case work .....	.50	.30	.30	1.10	(2/)
Other metal products ³	14.60	13.00	7.90	22.50	14.00
Copper (sheet metal and pipe)	9.80	8.20	6.00	14.50	11.10
Aluminum sheet metal	2.80	2.60	.40	6.20	.10
Galvanized sheet metal	1.60	1.70	1.30	1.50	2.30

See footnotes at end of table.

Table 9. Cost of Materials per \$1,000 of College Housing Construction Contract, by Type of Material and Region, 1960-61¹--Continued

Selected products and product groups	United States	North-east	North Central	South	West
Stone, clay, and glass products	\$143.80	\$151.70	\$139.50	\$150.40	\$117.60
Cement, concrete, and gypsum products	70.80	79.20	70.20	69.10	56.30
Ready-mix concrete	39.50	49.70	40.20	36.20	21.50
Concrete block and brick	12.70	14.70	9.70	14.70	10.30
Gypsum products	6.40	1.40	8.20	5.30	16.70
Precast concrete products	5.90	6.70	6.60	6.00	1.90
Cement	4.60	4.90	4.00	5.20	4.30
Lime	1.40	1.30	1.50	1.60	1.00
Structural-clay products	32.60	30.90	32.60	35.00	30.40
Brick	19.00	21.20	18.20	16.10	23.50
Ceramic tile	7.70	8.10	6.80	9.00	5.50
Structural tile	4.90	1.00	7.10	8.20	.30
Clay sewer pipe	1.00	.60	.50	1.70	1.10
Other stone, clay, and glass products	40.40	41.60	36.70	46.30	30.90
Marble and other cut stone	11.40	15.10	9.80	13.90	.80
Fiberglass insulation	6.50	6.90	6.90	5.70	6.90
Vinyl and vinyl asbestos tile	5.10	6.00	3.90	5.90	3.50
Sand and gravel	4.20	3.90	4.00	4.30	5.00
Window glass	3.80	4.60	2.40	4.60	3.50
Asphalt tile	3.20	1.30	4.10	2.30	7.70
Crushed rock and miscellaneous aggregate ...	1.60	.40	.30	4.20	.60
Asbestos insulation	1.20	1.30	2.10	.50	.90
Terrazzo .....	.90	.10	1.00	1.70	.40
Mirrors .....	.90	.80	1.70	.40	.10
Dirt fill .....	.40	.50	--	.70	--
Other clay products	1.20	.70	.50	2.10	1.50

See footnotes at end of table.

Table 9. Cost of Materials per \$1,000 of College Housing Construction Contract,
by Type of Material and Region, 1960-61¹--Continued

Selected products and product groups	United States	North-east	North Central	South	West
Lumber and lumber products ³	\$57.80	\$48.70	\$48.30	\$70.60	\$70.40
Millwork	42.70	33.00	40.70	51.30	48.50
Rough and dressed lumber	13.60	14.60	6.60	18.90	15.20
Electrical equipment, fixtures and wire ³	45.00	42.80	40.20	53.00	41.50
Lighting fixtures	12.50	10.00	12.40	15.40	11.80
Switch and panel boards	9.80	10.50	9.60	9.00	10.40
Conduit	7.80	8.30	6.60	8.80	6.90
Wire and cable	5.80	6.70	4.40	6.80	5.00
Noncurrent-carrying wire and devices	2.60	1.40	1.90	4.90	1.70
Current-carrying wiring devices	2.20	2.20	1.60	3.00	1.10
Intercommunication and fire alarm systems	2.00	2.40	1.30	1.60	2.20
Plumbing products ³	41.00	35.50	41.30	42.30	49.80
Fixtures	14.70	13.50	13.50	15.40	18.30
Steel and galvanized pipe	10.70	7.80	12.60	11.00	12.70
Valves and specialties	7.90	8.40	5.60	8.30	11.30
Cast iron pipe	7.00	5.30	8.70	7.60	5.40
Fixed equipment ³	37.60	35.00	47.00	31.60	36.00
Elevators	10.40	10.10	9.80	13.70	3.80
Furniture	8.60	7.20	12.00	9.00	2.10
Kitchen equipment and appliances	8.50	14.90	4.80	4.30	13.50
Refrigerators	4.00	1.00	9.20	1.00	6.20
Ranges and ovens	2.80	.10	6.50	(2/)	7.40
Incinerators .....	.70	1.00	.70	.30	1.20
Venetian blinds and shades .....	.60	.40	.20	1.50	.10
Water softener systems .....	.60	--	1.90	--	--
Playground equipment .....	.20	--	--	--	1.30

See footnotes at end of table.

Table 9. Cost of Materials per \$1,000 of College Housing Construction Contract,
by Type of Material and Region, 1960-61¹--Continued

Selected products and product groups	United States	North-east	North Central	South	West
Heating and ventilating equipment	³ \$31.70	³ \$35.50	³ \$31.20	\$30.20	\$27.60
Radiators, convectors, boilers, and hot water heaters	13.10	13.70	15.30	9.50	15.00
Temperature controls	4.80	6.20	4.20	3.10	7.60
Air conditioning equipment	4.50	4.30	3.60	7.20	.40
Blowers and fans	3.30	3.30	4.70	2.60	1.40
Unit heaters and ventilators	3.00	4.10	1.60	4.40	.20
Pumps	1.50	1.70	1.30	1.30	2.30
Storage tanks	1.20	1.40	.40	2.10	.70
Paints and other chemicals ³	6.40	6.90	6.00	6.70	5.50
Paint	4.30	4.80	3.40	4.80	3.60
Petroleum products ³	5.70	5.20	6.00	5.40	6.70
Asphalt and tar pitches	2.10	2.00	2.20	2.40	1.50
Asphalt felts	1.70	1.60	2.00	1.70	1.50
Asphalt paving	1.00	.70	.90	.80	2.10
Gasoline and diesel fuel .....	.60	.80	.50	.40	1.30
All other materials ³	4.80	5.10	3.70	5.70	8.90
Insulating board	1.90	2.00	1.80	2.30	.80
Lead .....	.80	1.20	.50	.70	.50
Rubber products .....	.40	.60	.10	.30	.70
Nursery products .....	.40	.10	.10	.10	2.90
Construction paper .....	.30	.10	.20	.80	.20
Construction equipment rental value or depreciation charge	15.90	11.40	19.20	11.60	25.00

¹ Construction of some projects extended from early 1959 to late 1962, but most construction took place in 1960-61.

² Less than \$0.05.

³ Includes value of products not shown separately. Values were rounded to the nearest

Appendix. Scope and Method of Survey

This study, designed to estimate man-hour requirements associated with construction of college housing projects, utilized data obtained from or related to activity at the construction sites as well as secondary sources such as the Census of Manufactures. College housing projects which were not federally aided were not included in this study.

Characteristics of the Universe and Selection of the Sample

The sampling frame comprised a complete listing of all CFA administered college housing projects indicated as being substantially completed during 1961. This listing of 201 projects with a total cost of about \$207 million provided a brief description of each project, its location, and cost. The projects were stratified by the four broad geographical regions previously noted and by cost class, as follows: Less than \$1 million, and \$1 million and over.

Projects in each cost class were then separated into two groups--those located in metropolitan areas and those located in nonmetropolitan areas.

A sample of 43 projects, approximately 1 in 5 from the listing, was selected. Since sampling within cells was not uniform owing to the number of projects within some cells, variable weights were assigned to projects. Construction on the projects extended from late 1959 to early 1962, but the greater portion took place during 1960-61.

Man-Hour Estimates

Customary presentation of employment data for construction projects includes estimates for on-site and off-site employment. Such a presentation is followed in this study. In addition, however, there is an economic distinction which can be made in analyzing man-hour requirements for construction. Basic grouping in this instance would be primary and secondary labor effects of construction expenditures, the primary sector including on-site employment plus the off-site employment directly related to activity at the job sites.

Primary man-hour requirements, for purposes of this report, include, in addition to all on-site labor, construction contractors' office employment, labor required in those manufacturing industries which fabricate construction materials used on the site--that is, the last stage of manufacturing, plus all trade, distribution, and services involved in placing construction materials and equipment at the job site. Secondary employment includes all other labor requirements necessary to produce and transport raw materials and semifinished products to factories which finally produce items used at construction sites.

Data for on-site man-hour requirements were generally collected from payroll records submitted by the various contractors, as required by law. All other labor requirements discussed below, whether considered primary or secondary, were established by use of secondary data.

Collection of On-Site Man-Hour Data

When college housing projects are constructed with the aid of Federal financing, each prime contractor and subcontractor is required by legislation to submit to the sponsoring body and CFA copies of each weekly payroll showing (with other information) daily and weekly hours worked, gross weekly earnings, and the occupation of each of the employees working on the particular project. These payrolls provided data for compiling on-site man-hour requirements, as well as data on wages for all hourly rated workers on the projects. Data for on-site salaried employees, not accounted for on payrolls submitted, were obtained from contractors by field representatives of the Bureau. In a few cases, the payroll records requested were not available, or were inadequate as data sources. For these situations, alternate projects were substituted.

Off-Site Man-Hours

From contractors and subcontractors cooperating in the study, a list was obtained of the value of each type of material used in the construction of sample projects. These material listings were classified into categories consistent with 4-digit Standard Industrial code as found in Census of Manufactures product groups. For each of these product groups, average amounts required for each \$1,000 of contract construction cost were determined. Once average requirements were calculated, each figure was reduced by a ratio representing the difference between valuation by the purchaser and valuation by the producer.¹⁰ Since all data reported by contractors were in purchasers' value, reduction to producers' value resulted in figures consistent with Census data published on these various components.

Primary Distribution Industries Employment

Primary man-hours in the trade, transportation, and service industries were estimated from the difference between producer and purchaser value for each construction material. The value differences were allotted to trade and transportation, and primary man-hours for each component of transportation and trade were then estimated from labor factors provided by BLS.

¹⁰ This ratio is based on valuation data provided by U.S. Department of Commerce, Office of Business Economics.

Primary Manufacturing Employment

Primary employment in manufacturing was considered to be that required to produce items in the construction bill of materials in their final stage of fabrication. In this stage, man-hours resulting from college housing construction were developed by multiplying average value of each construction material by the ratio of manufacturing man-hours to \$1,000 of production.¹¹

Secondary Employment in All Industries

Secondary employment is defined as the employment in all industries involved in production and transportation of building materials and equipment, from basic extraction to, but not including, the final manufacturing stage.

To calculate all secondary man-hours involved in construction materials and equipment, the 1958 interindustry study was used. For each group of materials, this study indicates the amount of secondary product required of each of its 78 industry sectors. The summation of these latter figures and labor factors furnished by BLS produced the volume of secondary employment required in each of the 78 sectors. Adjustments for price and productivity were made to arrive at data for the year consistent with the bill of materials.

Total Man-Hour Requirements

From each off-site stage (primary distribution, primary manufacturing, and secondary industry), a man-hour figure per \$1,000 of college housing construction was obtained. When these were combined with direct or on-site man-hours, the total employment effect, within the definition used by the study, was determined. However, the procedures used in estimating employment generated by construction of college housing did not include all such employment. Techniques used for estimating the off-site segment cover only employment generated by direct purchases of materials and supplies, and employment implicit in the depreciation of construction equipment. The following areas of employment related to volume of construction activity were not covered: (1) Architectural, surveying, estimating, and other planning employment; (2) inspection or supervision by the architect or the government during construction; (3) labor time involved in installations by public utility employees, as well as any site preparation not covered by the construction contract; (4) employment generated by purchases of movable furniture and equipment not included in the construction contract; (5) the "multiplier" effect of respending of wages and profits; and (6) the construction and equipment of new production facilities, if needed to supply construction materials.

¹¹ This ratio was established by using the 1961 Survey of Manufactures.