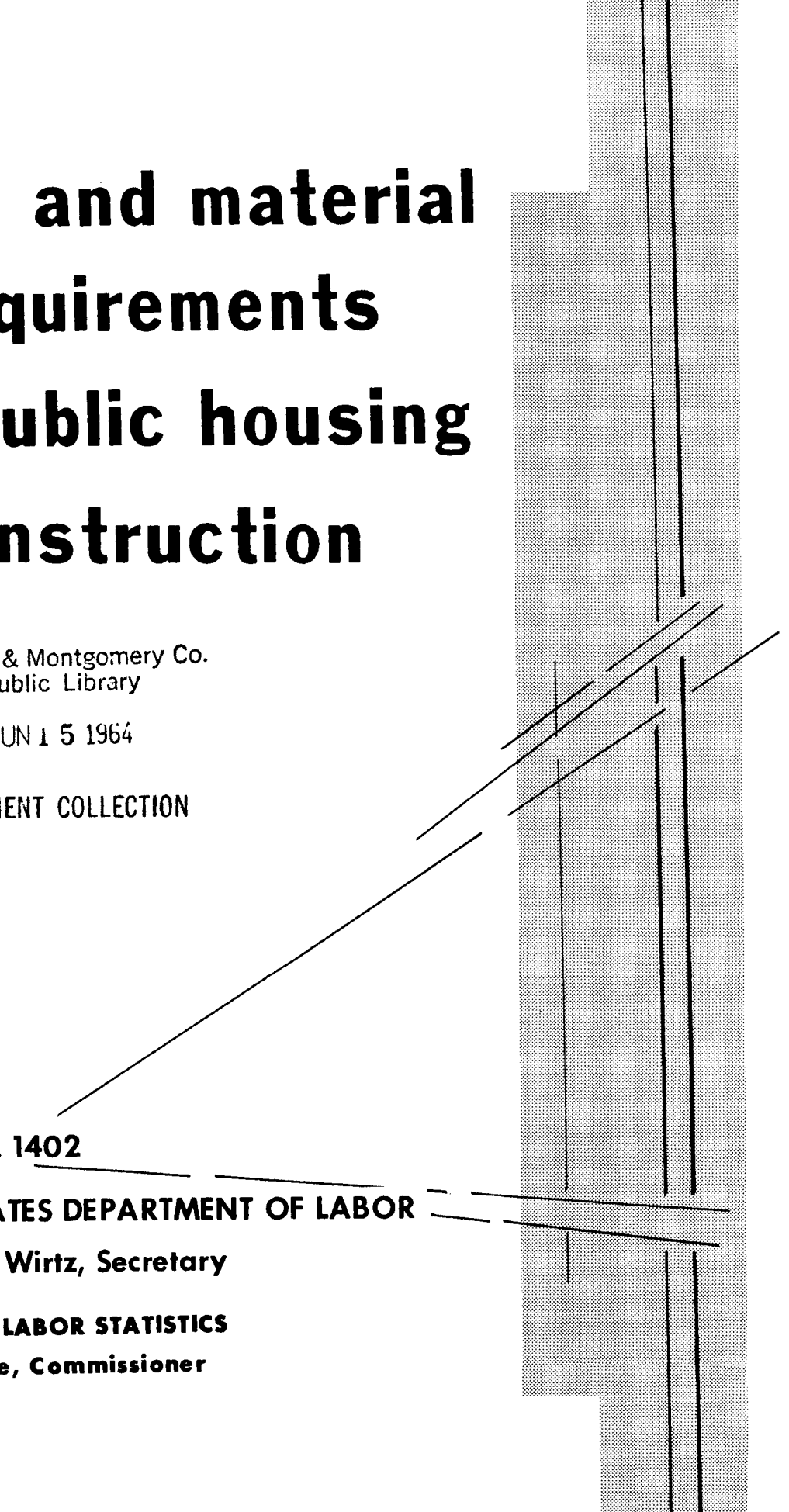
labor and material requirements for public housing construction



Bulletin No. 1402

UNITED STATES DEPARTMENT OF LABOR
W. Willard Wirtz, Secretary

BUREAU OF LABOR STATISTICS
Ewan Clague, Commissioner

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Preface

This study of labor and material requirements for construction of public housing is the fifth in a series of studies of various types of construction that might be affected by government action. Previous studies have been made of labor and material requirements for schools, highways, Federal office buildings, and hospitals. Currently in various stages of preparation are studies of civil works activities of the Corps of Engineers (such as construction of dams and levees, and dredging of channels) and other segments of the housing industry (such as private one-family and college student housing). Other studies are in planning stages.

The studies are being conducted in the Bureau of Labor Statistics, Division of Productivity Measurement, under the general direction of Leon Greenberg, Assistant Commissioner for Productivity and Technological Developments. This bulletin was prepared by Stanley F. Miller and Philip Jaynes 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, the Public Housing Administration, and the local housing authorities of the several States for making available data for tabulation to determine on-site labor requirements. The Bureau also wishes to thank the various contractors who supplied data on materials and equipment used, from which off-site labor requirements were calculated.

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LABOR AND MATERIAL REQUIREMENTS FOR PUBLIC 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 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.

The Bureau of Labor Statistics has undertaken a series of studies in order to measure labor requirements for various segments of the construction industry. Construction of public housing was selected for study because this segment represents one which could be significantly affected by governmental action.

The Public Housing Administration in its 16th annual report indicates that assistance had been provided, from 1937 through 1962, to more than 1,800 communities for construction of about 645,000 dwelling units to provide suitable living quarters for low-income families. At the end of 1962, some 119,000 additional units were in planning or construction stages. Expenditures for construction of public housing (Federal programs plus State and local programs) amounted to approximately $840 million during 1961. During the year, about 52,000 new public housing units were started. Annual expenditures for new, private residential units averaged $15.6 billion over the past 5 years. Public housing expenditures over the same period averaged $800 million.[1]

The 1960's will be years of unprecedented population growth. Housing needs will increase tremendously--it is estimated that by 1969, the annual net gain in household formation may reach 1.3 million. By 1970, the count of households may show a net gain for the decade of 9.2 million.[2]

With the expected acceleration of programs for highway construction and for urban renewal, losses to the presently existing housing supply can be expected to exceed the 300,000 a year average for the 1950's. Some portion of 16 million families who were ill-housed in 1960 will of necessity be rehoused during the decade. Continuation of the volume of housing production at the 1960 level would leave the country far short of its needs. To make any

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[1]U.S. Department of Commerce, Construction Review, July 1962.
[2]HHFA, 16th Annual Report, 1962, p. 13.

significant progress toward meeting these needs, it is estimated that production must reach the annual rate of 2 million dwelling units by the end of the decade. Public housing, should it maintain its historical share of this rate, would be producing 100,000 units annually.[3]

The major share of our increasing housing needs will have to be provided by new construction. This new construction will involve builders, prefabricators, material producers, mortgage lenders, and others, as well as Federal, State, and local governments.

Nature of the Survey

This report is based on findings of a survey of 31 public housing projects which were administered by the Public Housing Administration. Projects were selected in various States to be representative of four broad geographical regions of the conterminous United States.[4]

The survey was designed primarily to determine man-hours required by a fixed dollar volume ($1,000) of public housing construction. Man-hours, as defined by the survey, include both on-site construction employment and off-site employment required to produce 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 each construction trade. 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 covered

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[3]HHFA, 14th Annual Report, 1960, p. 16.

[4]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.

by construction contracts. Estimates were made of labor generated by money expended for contractors' overhead. The major portion of such overhead consists of administrative salaries. Overhead items, such as rent, bonds, insurance, taxes (including payroll taxes), welfare payments, and office supplies generate relatively little employment. 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.

Although the primary objective of this study was the determination of labor requirements for construction of public housing projects in the United States, examination of regional differences was undertaken. Public housing construction in every region of the country is faced with the same basic problem, but it is dealt with in different ways. The problem is to provide the desired number and quality of dwelling units at the lowest possible cost. This requires that design and construction of projects be adapted to the particular characteristics of each locality--the costs of labor and materials, the amount of space available, and other factors such as climate and topography. Since all of these characteristics vary from region to region, the type of project constructed will differ. In the Northeast region, for instance, the primary need is for large numbers of dwelling units located in congested metropolitan areas. This requirement, combined with high wage rates, has lead to the construction of multistory reinforced concrete buildings. Such buildings are most economical because they use a minimum amount of space and permit maximum use of laborsaving techniques in construction. In a different region, such as the South, the reinforced concrete structure may not be the most economical. Load-bearing masonry or wood structures are favored for southern projects because there is less need to conserve space, wage rates are lower, and average project size is small. In other regions of the country, there is a more even distribution of structural types, reflecting more local variation in housing requirements and construction conditions.

Because of variations in man-hour requirements between regions and within regions by structural type, caution must be used in projecting the results of this study to future years. If the regional or structural distribution of projects changes in the future, then average man-hour requirements would also change.

A more detailed description of the scope of the survey and method of sample selection is given in the appendix.

General Survey Findings and Characteristics

Construction of public housing projects in 1959-60 created 236 man-hours of employment for each $1,000 of construction contract cost. Employment at the construction sites accounted for 114 man-hours, while 122 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 in addition to the 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	236	100
On-site construction	114	48
Off-site	122	52
Construction	12	5
Manufacturing	64	28
Transportation, trade, and service	36	15
Other industries (including mining)	10	4

Average construction cost (excluding site preparation and planning costs) of public housing projects studied was about $1.3 million. Construction of these projects was accomplished during the period from early 1959 to middle 1961; however, the greater portion took place during 1959-60. Length of construction time for the average project studied was 58 weeks, thus providing the equivalent of continuous work for about 74 workers (83 man-years) at construction sites, and for a slightly lesser amount of employment in off-site activities.[5]

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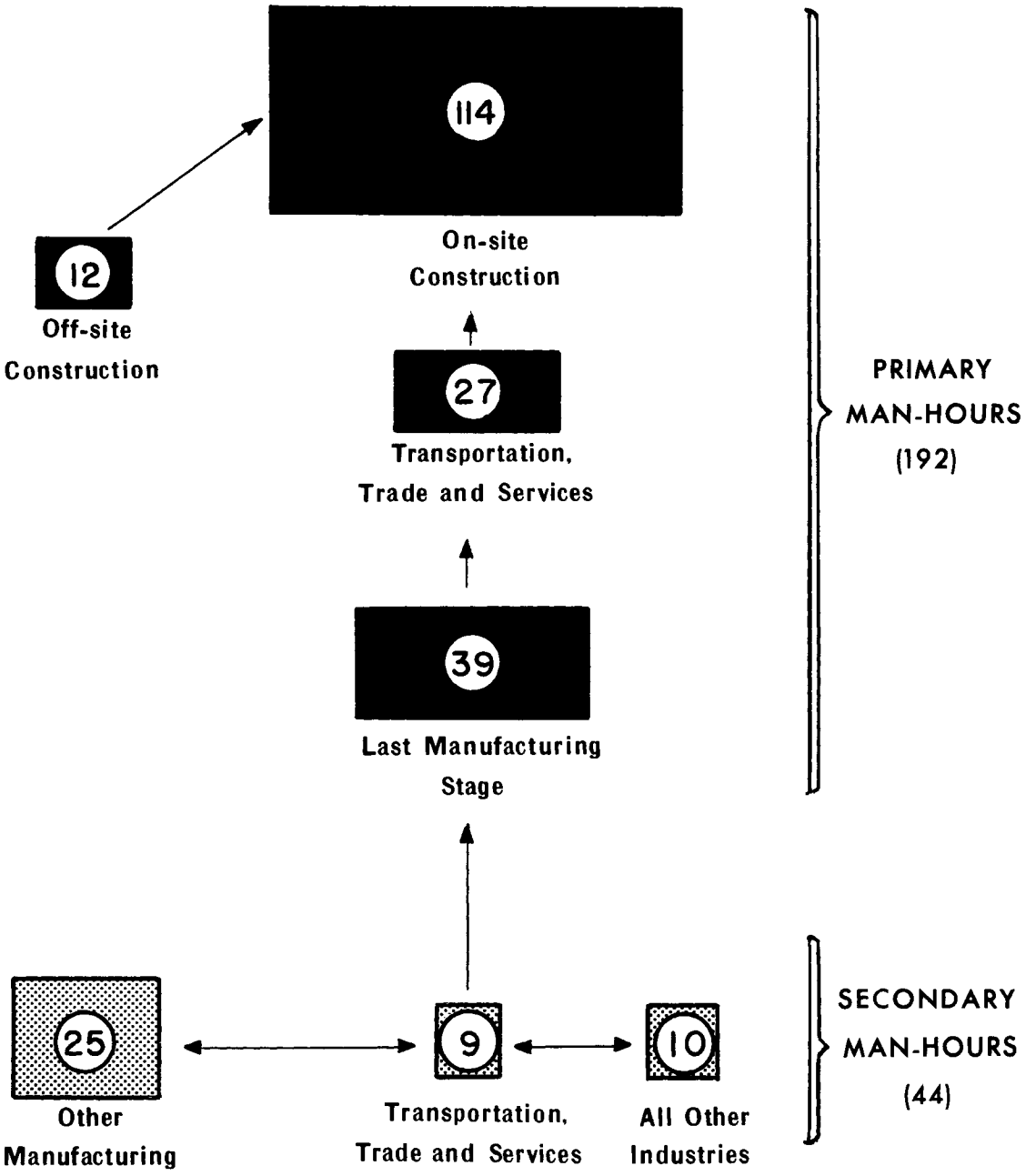
[5]The annual employment estimate of construction workers is based on 50 times the 1959 average employment in contract building construction work of 35.8 hours per week as reported in the Bureau's Earnings and Hours Series. For other types of employment, 2,000 hours were considered as 1 year's employment.

Chart 1. Distribution of 236 Man-Hours for Each $1,000 of Public Housing Construction Contract, 1959-60



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During recent years, about $800 million have been expended annually for construction of public housing. At the current rate, therefore, such construction has created about 51,000 jobs annually for on-site activities and approximately 49,000 for related off-site work. In order to meet the anticipated annual need for public housing, construction and related employment would need to be substantially greater than current levels.

The study disclosed wide variations in man-hour and materials requirements among projects, reflecting differences in size of project, geographical location, and local practices. Marked differences were noted in such related items as average hourly earnings and site wages as a percentage of construction cost. Material purchases amounted 47.5 percent of the construction dollar expended, while wages for on-site man-hours were 35.5 percent. (See chart 2.) Earnings for on-site labor for all projects averaged $3.14 per hour.

Building Characteristics

The 31 housing projects selected for study varied in size from one with 10 dwelling units to one containing almost 1,000. Square feet of floor area ranged from 9,000 to over 1 million. Construction contract costs ranged from $113,000 to about $11 million. Construction costs per square foot and per dwelling unit ranged from about $8 to $15 and approximately $8,000 to $13,000, respectively. Costs per square foot and per dwelling unit by region and by selected characteristics are presented in table 1. Average size and construction cost of projects studied were as follows:

	Average
Number of dwelling units	125
Floor area (square feet)	124,000
Construction contract cost	$1,324,000
Construction cost per dwelling unit	$10,598
Construction cost per square foot	$10.68

Projects can be classified by structural type into three categories: reinforced concrete, load-bearing masonry, and wood. Each of the three types has a slightly different mixture of man-hour and materials requirements associated with its construction. Reinforced concrete is generally used for construction of multistory, elevator-equipped buildings. All of the reinforced concrete projects were located in metropolitan areas, compared to 50 percent of the wood and 38 percent of the load-bearing masonry projects.

Reinforced concrete projects represented 45 percent of all dwelling units, followed by load-bearing masonry, 30 percent, and wood with 13 percent. Projects containing a mixture of structural types were constructed of

Chart 2. Percent Distribution of On-Site Wages and Materials Used for Each $1,000 of Public Housing Construction Contract, 1959-60

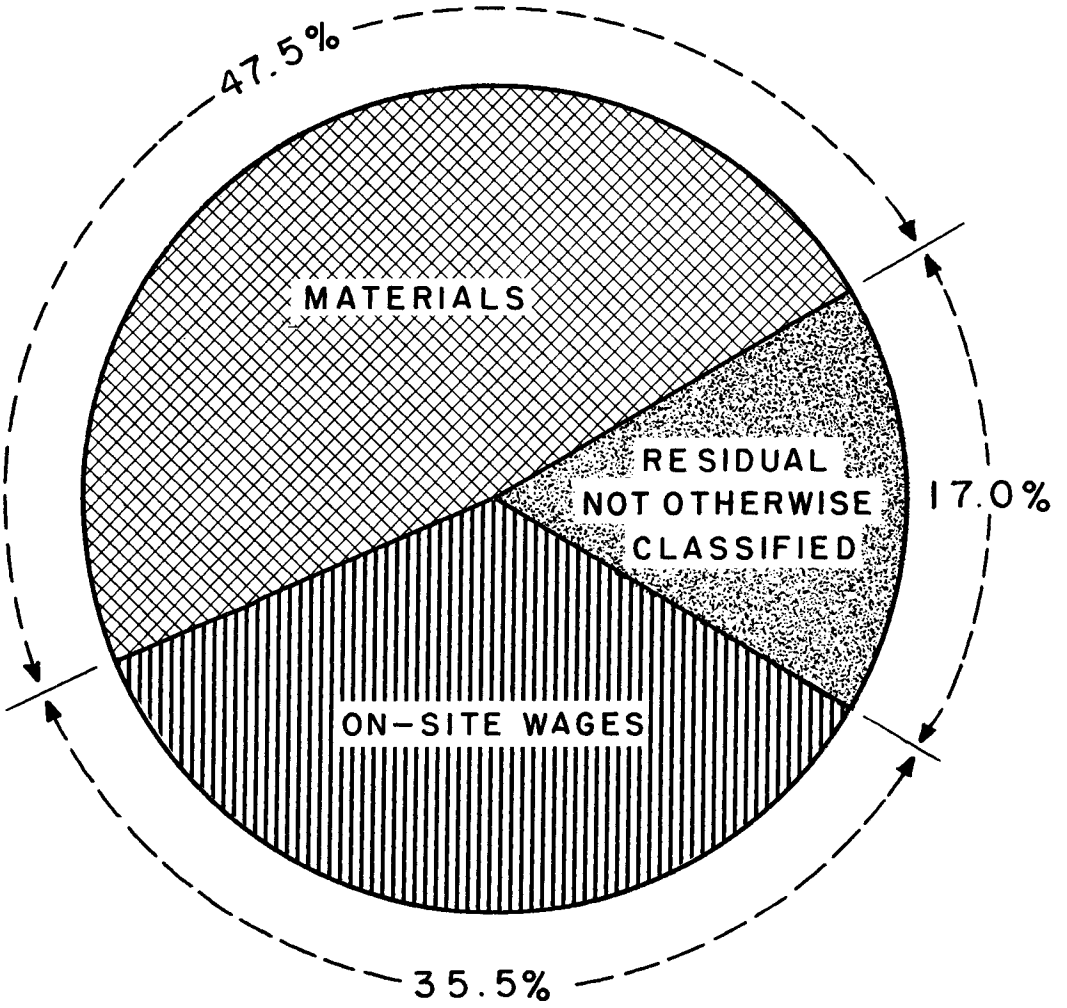

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Table 1. Cost per Square Foot and per Dwelling Unit for Public Housing Projects, by Selected Characteristics and Region, 1959-60[1]

Characteristic	United States		South		Other regions[2]	
	Cost per--					
	Square foot	Dwelling unit	Square foot	Dwelling unit	Square foot	Dwelling unit
All projects	$10.68	$10,598	$9.36	$9,402	$11.51	$11,341
Construction cost group:						
Under $1,000,000	$10.92	$10,155	$10.04	$9,462	$12.07	$11,722
$1,000,000-$1,999,999...	10.73	10,966	10.24	10,249	11.06	11,458
$2,000,000 and over	10.65	10,661	7.60	8,495	11.57	11,221
Type of structure:[3]						
Reinforced concrete	11.32	11,188	--	--	11.32	11,188
Load-bearing masonry	9.63	9,962	9.13	9,409	11.21	11,833
Wood	10.12	9,792	9.98	9,385	10.45	10,848

[1]Although construction on some projects extended into 1961, most construction was performed in 1959-60.

[2]Insufficient data to warrant separate presentation by characteristics for the other three regions.

[3]Does not include two projects having a mixture of different types of structures.

mixtures of wood and reinforced concrete units. The Northeast region had a preponderance of reinforced concrete projects, located near such cities as New York and Philadelphia. In the North Central and Western regions, the three structural types were more evenly distributed. There were no reinforced concrete projects in the South; most of the dwelling units were constructed of load-bearing masonry. The type of structure used by projects in the different regions is strongly dependent on the extent to which construction takes place in metropolitan areas. In the South, 79 percent of all projects studied were located in nonmetropolitan areas; in regions outside the South, only 12 percent of the projects were in such areas.

About one-fifth of all projects consisted of buildings constructed with wood flooring (mostly for second story floors in two-storied buildings). Concrete covered with resilient tile was used in all buildings, except in two projects, for ground level floors. Buildings in about 50 percent of the projects were constructed with built-up roofing placed on concrete or wood. Those in the other half had wooden roofs covered with asbestos shingles. Roofing on buildings in one project was clay tile placed on concrete. Areas for administrative activities or community services were provided for in one-sixth of the projects.

Building Costs

Table 1 presents two different measures of building cost, expressed as cost per square foot and cost per dwelling unit. The relationships shown vary slightly because of differences from the national average of 992 square feet per dwelling unit. The following tabulations show labor and materials costs per square foot by regions and by structural types.

	Labor and materials cost per square foot by--region				
	United States	North-east	North Central	South	West
Total	$10.68	$10.91	$12.25	$ 9.36	$12.90
Labor cost	3.79	4.01	4.56	3.14	4.60
Materials cost	5.07	4.86	5.63	4.74	6.62
Overhead and profits	1.82	2.04	2.06	1.48	1.68

	Type of structure		
	Reinforced concrete	Load-bearing masonry	Wood
Total	$11.32	$9.63	$10.12
Labor cost	4.19	3.45	3.18
Materials cost	5.00	4.82	5.11
Overhead and profits	2.13	1.36	1.83

The difference in cost between regions probably results from the interaction of several factors. Higher costs in the Western and North Central regions may be due in part to greater distances from sources of supply for some materials, with consequent higher shipping costs. Lower costs per square foot in the South could result from a combination of lower wage costs and smaller expenditures for such items as insulation and heating plants, because of the milder climate. Cost is influenced by the type of building constructed, as reflected not only by the basic structural type, but by differences in design qualities and durability. Costs per dwelling unit by region are as follows:

	Cost per dwelling unit
United States	$10,598
Northeast	11,192
North Central	11,367
South	9,402
West.....	11,951

Cost figures shown in this study apply to construction cost only. They do not include expenses for planning, acquisition of land, or site preparation. Also, these figures refer to initial cost. In order to make comparisons between different structural types as to which is most economical, one would also have to consider long-range factors. The project type which is cheapest to construct may not be the best value, because of lesser durability or higher maintenance costs in the long run.

On-Site Man-Hour Requirements

Man-hour requirements per dollar of construction cost are obtained by dividing total on-site man-hours reported by total construction cost. This result is in turn multiplied by 1,000 in order to determine requirements for each $1,000 of construction cost. For projects studied, man-hour requirements varied from a low of 64 to a high of 192. The United States average was 114 (table 2).

The most significant regional variation was the high number of man-hours required for projects in the South. There were at least three reasons for this. First, southern projects had a small average size. This meant that there was less opportunity to use laborsaving equipment and procedures. Second, most of the projects constructed in the South were built of load-bearing masonry. This structural type tends to have higher man-hour requirements than wood or reinforced concrete. The South's increased utilization of labor took place mostly in the unskilled and semiskilled categories (table 3). In this region, there was less tendency to use more labor on southern projects in skilled categories, such as carpentry or bricklaying, possibly because it is more difficult to substitute equipment for skilled labor, whereas a ditchdigging machine can be substituted for an unskilled ditchdigger.

When labor requirements are expressed as man-hours per 1,000 square feet or per dwelling unit, the picture is slightly different. Regional variations are in the same direction but of lesser magnitude. Man-hour requirements in the South are 43 percent higher per $1,000 of construction contract cost; 17 percent higher per 1,000 square feet; and 19 percent higher per swelling unit than the average for the rest of the United States.

Man-hour requirements appear to be lower for larger projects. The reason for this is that such projects afford greater opportunity for the use of laborsaving equipment, such as cranes, hoists, and conveyors. Also, organization and management may be more efficient on the larger projects. It appears that the factor of project size exerts itself most strongly on the very small projects, which have quite high man-hour requirements, and on the very large projects, where substantial savings in man-hour requirements are achieved. For projects in the intermediate-size range there is not as strong a relationship between size and man-hour requirements.

Another source of variations in man-hour requirements is type of structure. Requirements are lowest for reinforced concrete, next highest for wood, and highest for load-bearing masonry. It is not clear, however, whether these variations are due to inherent structural differences, or if they are mainly a result of adjustments to regional variations in wage rates. Where comparisons within the same region are possible, load-bearing masonry has slightly higher man-hour requirements than the other structural types. A comparison of man-hour requirements between wood and reinforced concrete

Table 2. On-Site Man-Hour Requirements for Public Housing Projects, by Selected Characteristics and Region, 1959-60[1]

Characteristic	United States			South			Other regions[2]		
	Man-hours per--								
	$1,000 of cost	1,000 square feet	Dwelling unit	$1,000 of cost	1,000 square feet	Dwelling unit	$1,000 of cost	1,000 square feet	Dwelling unit
All projects	113.7	1,214	1,205	142.1	1,331	1,336	99.1	1,140	1,124
Construction cost group:									
Under $1,000,000	139.8	1,492	1,419	160.3	1,609	1,516	102.4	1,236	1,200
$1,000,000-$1,999,999..	116.1	1,246	1,273	127.9	1,309	1,311	108.9	1,204	1,247
$2,000,000 and over	99.2	1,057	1,058	121.6	924	1,033	94.8	1,096	1,064
Type of structure:[3]									
Reinforced concrete	94.2	1,066	1,054	--	--	--	94.2	1,066	1,054
Load-bearing masonry ...	137.9	1,326	1,374	143.6	1,311	1,351	122.7	1,376	1,452
Wood.....	124.5	1,260	1,219	138.5	1,382	1,300	93.0	971	1,008

[1]Although construction on some projects extended into 1961, most construction was performed during 1959-60.

[2]Insufficient data to warrant separate presentation by characteristics for the other three regions.

[3]Does not include two projects having a mixture of different types of structures.

Table 3. On-Site Man-Hour Requirements per $1,000 for Public Housing Projects, by Proportion of Lower Skilled Man-Hours, Region, and Type of Structure, 1959-60[1]

Percent lower skilled man-hours of total	Man-hours per $1,000 of construction cost			
	All types	Reinforced concrete	Load-bearing masonry	Wood
United States, total	113.7	94.2	137.9	124.5
25.0 and under	96.0	85.8	122.7	89.5
25.1 to 35.0	115.0	108.4	134.4	106.4
35.1 to 45.0	138.7	--	138.9	138.5
45.1 and over	160.4	--	160.4	--
South, total	142.1	--	143.6	138.5
25.0 and under	--	--	--	--
25.1 to 35.0	134.4	--	134.4	--
35.1 to 45.0	138.7	--	138.9	138.5
45.1 and over	160.4	--	160.4	--
Other regions,[2] total	99.1	94.2	122.7	93.0
25.0 and under	96.0	85.8	122.7	89.5
25.1 to 35.0	108.2	108.4	--	106.4
35.1 to 45.0	--	--	--	--
45.1 and over	--	--	--	--

[1]Although construction on some projects extended into 1961, most construction was performed in 1959-60.

[2]Insufficient data to warrant separate presentation by characteristics for the other three regions.

is not as definite. For the United States as a whole, reinforced concrete has lower man-hour requirements, but this is due largely to the influence of high man-hour requirements for wood structures in the South. The two types have very similar labor requirements outside the South. It is interesting to note the sharp differences in man-hour requirements for wood structures between the South and the rest of the United States. The lower man-hour requirements in regions other than the South are partly due to greater use of prefabricated wall and roof sections.

There is less difference between regions in man-hour requirements for load-bearing masonry structures. This suggests that there may be less scope for the introduction of laborsaving techniques in the construction of these buildings. It may be more difficult to make use of such innovations as prefabrication in the construction of load-bearing masonry structures. Comparison of man-hour requirements by regions is shown in the following tabulation:

	Regional comparisons of man-hour requirements				
	United States	North-east	North Central	South	West
Man-hours per--					
$1,000 of contract cost...	113.7	95.9	106.0	142.1	98.4
1,000 square feet.....	1,214	1,046	1,299	1,331	1,270
Dwelling unit.....	1,205	1,073	1,205	1,336	1,176

Requirements by Occupation

Regional variations in man-hour requirements for different trades (table 4) reflect differences in design, work practices, and wage rates. The sharpest contrasts are noted in the division between skilled and unskilled workers. The South had about 45 percent of all man-hours performed by unskilled and semiskilled workers, as compared with 25 to 28 percent for the other regions.

Within the skilled category, regional variations are most directly related to differences in structural types. The distinctive characteristics of reinforced concrete construction are high man-hour requirements for lathers, ironworkers, and plumbers; with low requirements for carpenters and painters. Load-bearing masonry construction has high requirements for bricklayers. Wood construction has high requirements for carpenters and painters and low requirements for electricians and plumbers (table 5).

The relative proportions of skilled and unskilled labor used depend partly on the type of structure being built and partly on the level of wages. Low wages make it economical to use greater quantities of unskilled labor.

Table 4. On-Site Man-Hour Requirements per $1,000 of Public Housing Construction Cost and Percent Distribution, by Occupation and Region, 1959-60[1]

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	113.7	100.0	95.9	100.0	106.0	100.0	142.1	100.0	98.4	100.0
General supervisors	2.8	2.5	1.9	2.0	3.6	3.4	3.7	2.6	2.1	2.1
Professional, technical, and clerical	1.7	1.5	1.7	1.8	2.2	2.1	1.2	.8	2.0	2.0
Asbestos workers	.5	.4	.7	.7	.8	.8	.2	.1	.3	.3
Bricklayers	8.6	7.6	7.1	7.4	6.8	6.4	13.2	9.3	1.6	1.6
Carpenters	21.8	19.1	15.9	16.6	21.6	20.4	25.8	18.1	31.9	32.5
Cement finishers	3.5	3.1	3.4	3.6	3.1	2.9	3.5	2.5	4.1	4.2
Electricians	4.7	4.1	4.9	5.1	5.2	4.9	4.3	3.0	4.7	4.8
Elevator mechanics	.3	.3	.7	.7	.4	.4	(2/)	(2/)	.1	.1
Glaziers	.4	.4	.4	.4	.8	.8	.1	.1	.7	.7
Lathers	3.6	3.2	6.4	6.7	2.4	2.3	1.7	1.2	1.2	1.2
Operating engineers	3.1	2.7	2.1	2.2	3.7	3.5	3.8	2.7	3.6	3.7
Ornamental ironworkers	1.0	.9	1.9	2.0	1.2	1.1	.1	.1	.2	.2
Painters	5.0	4.4	4.0	4.2	4.1	3.9	6.5	4.6	5.3	5.4
Plasterers	4.1	3.6	4.6	4.8	3.7	3.5	3.9	2.7	3.2	3.3
Plumbers	8.9	7.8	10.4	10.8	11.5	10.8	6.2	4.4	7.3	7.4
Reinforcing ironworkers	1.1	1.0	1.3	1.4	1.3	1.2	.7	.5	1.8	1.8
Roofers	.9	.8	.7	.7	.3	.3	1.5	1.1	.8	.8
Sheet-metal workers	1.1	1.0	.7	.7	2.4	2.3	.7	.5	1.3	1.3
Soft floor layers	.3	.3	.2	.2	(2/)	(2/)	.6	.4	.6	.6
Structural ironworkers	.2	.2	(2/)	(2/)	1.0	.9	.1	.1	.4	.4
Tile setters	.2	.2	.1	.1	.1	.1	.4	.3	.1	.2
Truckdrivers	1.0	.9	.7	.7	1.0	.9	1.1	.8	1.3	1.3
Helpers and tenders	5.4	4.7	5.2	5.4	4.9	4.6	6.6	4.6	2.8	2.8
Laborers	29.9	26.2	17.1	17.9	21.9	20.7	51.6	36.2	18.9	19.2
Custodial workers	1.4	1.2	2.7	2.8	1.0	.9	.4	.3	.8	.8
Other	2.2	1.9	1.1	1.1	1.0	.9	4.2	3.0	1.3	1.3

[1]Although construction on some projects extended into 1961, most construction was performed in 1959-60.
[2]Less than 0.05 percent.

Table 5. On-Site Man-Hour Requirements per $1,000 of Public Housing Construction Cost and Percent Distribution, by Occupation and Type of Structure, 1959-60[1]

Occupation	Reinforced concrete		Load-bearing masonry		Wood	
	Man-hours	Percent	Man-hours	Percent	Man-hours	Percent
All occupations	94.2	100.0	137.9	100.0	124.5	100.0
General supervisors	2.2	2.3	3.3	2.4	4.0	3.2
Professional, technical, and clerical	2.1	2.2	1.3	.9	.9	.7
Asbestos workers	.6	.6	.4	.3	.1	.1
Bricklayers	6.6	7.0	13.8	10.0	6.9	5.5
Carpenters	13.0	13.8	26.1	18.9	33.3	26.7
Cement finishers	4.0	4.2	3.0	2.2	3.0	2.4
Electricians	5.1	5.4	4.8	3.5	2.8	2.2
Elevator mechanics	.8	.8	--	--	--	--
Glaziers	.4	.4	.1	.1	.1	.1
Lathers	6.0	6.4	2.3	1.7	.4	.3
Operating engineers	2.5	2.6	3.3	2.4	4.2	3.4
Ornamental ironworkers	2.0	2.1	.1	.1	.1	.1
Painters	3.4	3.6	6.1	4.4	8.1	6.5
Plasterers	4.4	4.6	4.7	3.4	1.8	1.4
Plumbers	11.3	12.0	7.8	5.7	5.5	4.4
Reinforcing ironworkers	1.5	1.6	.8	.6	.1	.1
Roofers	.5	.5	1.5	1.1	1.1	.9
Sheet-metal workers	.6	.6	1.2	.9	.9	.7
Soft floor layers	.2	.2	.5	.4	.8	.6
Structural ironworkers	.1	.1	.1	.1	(2/)	(2/)
Tile setters	.1	.1	.4	.3	.4	.3
Truckdrivers	.6	.6	1.3	.9	1.3	1.0
Helpers and tenders	6.3	6.7	6.9	5.0	1.8	1.4
Laborers	16.6	17.6	44.5	32.3	41.8	33.6
Custodial workers	2.6	2.8	.8	.6	.1	.1
Other	.8	.8	2.9	2.1	5.0	4.0

[1]Although construction on some projects extended into 1961, most construction was performed in 1959-60.

[2]Less than 0.05 percent.

If wage rates are higher there is a stronger incentive to substitute labor-saving equipment and techniques for unskilled workers. There is probably less scope for the replacement of skilled workers, even if wages are quite high. The present nature of building construction is such that mechanization cannot be carried as far as it can in many other industries. Future expansion in the construction industry may create a need for more mechanization in order to satisfy housing demand at low cost.

Apprentice Man-Hours

Apprentices in formal, registered apprenticeship programs[6] accounted for 3.7 percent of total on-site man-hours and 6.0 percent of skilled man-hours (table 6). Apprentice glaziers and electricians accounted for a greater proportion of skilled man-hours for their craft than all others--12.9 and 12.2 percent, respectively. The greatest proportion of apprentice man-hours were reported in the West. Formal apprentice training programs do not exist or are just evolving for three occupations working on public housing projects--asbestos workers, elevator mechanics, and operating engineers. Training in these occupations is usually accomplished on an informal basis by assisting a journeyman in his work until the trainee is considered as fully qualified to perform at journeyman level of proficiency. In some instances, predetermined time periods of on-the-job training are required to become 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 equipment operation, are 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 about one-half of all man-hours worked. This ratio was somewhat lower in the Northeastern and North Central regions, and higher in the South and West. Projects were on the average smaller in the two latter regions. Smaller project size meant that more of the work was done by the general contractor, because in many lines there was insufficient work to make issuing subcontracts worth while. Large projects on the average use more subcontractors and have a smaller proportion of the work done by the general contractor. This is illustrated in table 7 and in the following tabulation, where the average number of subcontractors increases from 15 for the smallest size class to 33 for the largest.

Multistory reinforced concrete projects used more subcontractors for a given project size. This may be due to different structural characteristics, or perhaps the practice of subcontracting is more highly developed in large metropolitan areas where the multistory projects are located.

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[6] 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 6. Apprentice Man-Hours as a Percent of Total Man-Hours Worked on Public Housing Construction, by Occupation, Region, and Type of Structure, 1959-60[1]

Occupation	Region					Type of structure		
	United States	North-east	North Central	South	West	Reinforced concrete	Load-bearing masonry	Wood
All workers	3.7	4.0	3.9	2.9	6.0	4.1	3.7	2.0
Skilled trades only	6.0	5.9	5.9	5.6	8.5	6.5	7.2	3.4
Bricklayers	4.8	5.9	4.6	4.1	7.8	4.5	5.7	3.7
Carpenters	4.9	7.1	5.0	3.1	5.9	7.2	4.5	1.8
Cement finishers	8.1	12.3	8.7	2.1	11.0	11.0	3.4	7.1
Electricians	12.2	.5	10.2	28.7	12.8	2.8	26.6	29.2
Glaziers	12.9	29.8	2.2	1.8	5.8	26.3	6.5	--
Lathers	8.7	6.7	13.6	12.6	15.0	9.0	12.4	--
Ornamental ironworkers	3.0	3.5	1.7	--	1.6	3.5	--	--
Painters	3.9	4.9	7.4	1.3	7.0	4.4	4.0	1.1
Plasterers	4.8	4.3	5.2	3.4	13.4	4.3	5.7	3.6
Plumbers	9.0	7.9	7.5	8.5	21.4	8.8	10.6	6.8
Reinforcing ironworkers	3.0	--	--	12.2	3.0	.1	11.9	--
Roofers	8.7	3.9	8.9	12.4	.4	--	12.4	13.4
Sheet-metal workers	9.6	2.1	3.8	30.6	5.6	5.1	20.7	--
Soft floor layers	5.7	--	21.9	3.9	17.4	--	6.4	7.3
Structural ironworkers	7.0	--	8.8	--	4.5	3.0	--	--
Tile setters	4.4	2.2	--	5.8	--	--	5.8	--

[1]Although construction on some projects extended into 1961, most construction was performed in 1959-60.

Table 7. Average Number of Subcontractors per Public Housing Project, by Selected Characteristics and Region, 1959-60[1]

Characteristic	United States	South	Other regions[2]
All projects	20	14	28
Construction cost group:			
Under $1,000,000	15	14	31
$1,000,000-$1,999,999	27	--	30
$2,000,000 and over	33	--	37
Type of structure:[3]			
Reinforced concrete	33	--	33
Load-bearing masonry	17	15	22
Wood	15	13	22

[1]Although construction on some projects extended into 1961, most construction was performed in 1959-60.

[2]Insufficient data to warrant separate presentation by characteristics for the other three regions.

[3]Does not include two projects having a mixture of different types of structures.

	Average number of subcontractors per public housing project by region
United States	20
Northeast	29
North Central	28
South	14
West	26

Masonry, plumbing and heating, and plastering and lathing were the three largest subcontracting groups, accounting for about 54 percent of the total man-hours for special trades subcontractors (table 8). Projects with wood buildings had a smaller proportion of total man-hours for each of these three trades than did the other structural types. On the other hand, man-hours of painting subcontractors were relatively more important for the wood structural type.

The South used fewer subcontractors than did the other regions for comparable projects, possibly because most of the southern projects were located in nonmetropolitan areas.

The Cost of Direct Wages

Wages payments for on-site man-hours averaged 35.5 percent of contract cost for all public housing projects studied. Total wage payments are the product of man-hours worked and average wage rates. The ratio of wage payments to contract cost was remarkably constant, not only in terms of regional averages, but for individual projects as well. Half of the projects studied had a ratio between 32 percent and 37 percent. The constancy of this ratio means that high man-hour requirements are associated with low wages and vice versa. This indicates that construction techniques are adapted to regional differences in labor conditions through use of more or less mechanized equipment.

Table 9 shows average hourly earnings for on-site man-hours worked. Projects constructed in the South had a markedly lower average. There were two significant reasons for this. First, wage levels are generally lower in the South than in other regions. Second, wages tend to be lower in nonmetropolitan areas of a given geographic region. The majority of the southern projects were located in nonmetropolitan areas, while most projects in other regions were in metropolitan areas. So the usual difference in wage rates is accentuated. A comparison of hourly earnings by region is as follows:

	Regional comparison of hourly earnings				
	United States	North-east	North Central	South	West
Average hourly earnings ..	3.14	3.84	3.51	2.36	3.63
Wages as a percent of contract cost	35.5	36.8	37.2	33.5	35.7

Wage rates appeared higher for multistory, reinforced concrete projects, compared to other type projects in the same regions. This may be because all of the reinforced concrete projects were located in metropolitan areas, while some of other type projects were not. There may also be differences in the average skill levels required for construction of the various structural types, leading to differences in average wage rates.

Table 8. Percent of Total On-Site Man-Hour Requirements for Public Housing Construction, by Type of Contractor, Region, and Type of Structure, 1959-60[1]

Type of contractor	Region					Type of structure		
	United States	North-east	North Central	South	West	Reinforced concrete	Load-bearing masonry	Wood
All types	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
General	49.2	42.6	38.9	56.9	57.0	39.8	52.2	60.0
Special trades	50.8	57.4	61.1	43.1	43.0	60.2	47.8	40.0
Concrete	2.4	1.1	3.9	3.1	.7	2.4	2.5	3.6
Electrical	4.3	5.1	5.1	3.3	5.0	5.2	3.8	2.6
Masonry	8.3	10.3	8.8	7.6	2.7	11.9	8.8	2.7
Painting	4.1	4.0	4.4	3.8	5.5	3.6	3.7	6.1
Plastering and lathing	7.1	10.9	6.9	4.8	4.1	10.6	6.6	.2
Plumbing and heating	12.3	13.8	16.0	10.0	10.8	14.7	11.6	8.6
Roofing and sheet metal	1.3	.9	.7	1.7	1.7	.6	2.0	.9
Site preparation and excavation	2.3	2.3	4.7	1.4	1.7	2.9	3.7	1.6
Structural and ornamental iron	1.4	2.5	1.7	.2	2.3	2.8	.2	.1
All other types	7.4	6.6	8.9	7.2	8.3	5.6	4.8	13.5

[1]Although construction on some projects extended into 1961, most construction was performed in 1959-60.

Table 9. Average On-Site Earnings for Public Housing Construction Projects, by Selected Characteristics and Region, 1959-60[1]

Characteristic	United States		South		Other regions[2]	
	Average hourly earnings	Wages as percent of contract	Average hourly earnings	Wages as percent of contract	Average hourly earnings	Wages as percent of contract
All projects	$3.14	35.5	$2.36	33.5	$3.71	36.8
Construction cost group:						
Under $1,000,000	$2.48	34.7	$2.14	34.3	$3.47	35.6
$1,000,000-$1,999,999...	3.07	35.6	2.55	32.6	3.44	37.5
$2,000,000 and over	3.65	36.2	2.71	32.9	3.88	37.3
Type of structure:[3]						
Reinforced concrete.....	3.93	37.0	--	--	3.93	37.0
Load-bearing masonry	2.61	35.9	2.41	34.6	3.22	39.5
Wood	2.52	31.4	2.22	30.8	3.52	32.7

[1]Although construction on some projects extended into 1961, most construction was performed in 1959-60.

[2]Insufficient data to warrant separate presentation by characteristics for the other three regions.

[3]Does not include two projects having a mixture of different types of structures.

Off-Site Employment

For each 114 man-hours of employment performed at construction sites of public housing projects, 122 additional man-hours were required to produce and distribute necessary construction materials, supplies and equipment. Thus a total of 236 man-hours were generated for every $1,000 expended for construction cost.

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 producing 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 interindustry transactions eventually affect all additional industries such as agriculture, forestry, and mining.

There are other types of employment related to construction activities which this study did not attempt to cover. Groups of workers who would be affected by construction of public housing projects, but were not considered for this report, would include employees of architectural firms, utility companies, and State and local government. These employees and their functions were not generally included in construction contract costs. A large area of employment, also excluded from calculations of man-hour effects, 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 employment 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 the following tabulation, primary man-hour requirements per $1,000 of construction cost, estimated at 192, arise in activities at the site and those most directly related to the 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 shipment to construction sites, and employees in transportation, trade, and service organizations dealing in materials used at these construction sites.

	Man-hours per $1,000 of construction contract cost		
	Total	Primary	Secondary
Total	236	192	44
On-site construction	114	114	--
Off-site	122	78	44
Construction	12	12	--
Manufacturing	64	39	25
Transportation, trade, and services	36	27	9
All other (including mining)	10	--	10

Secondary man-hour requirements have been defined as those associated with all other requirements related indirectly to needs at the sites. Such activities, totaling 44 man-hours or approximately 19 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 contractors 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 12 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.

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[7]Secondary man-hours were estimated on the basis of a study made by the Bureau of 1947 interindustry relationships. See W. Duane Evans and Marvin Hoffenberg, "The Interindustry Relations Study for 1947," Review of Economics and Statistics, Vol. XXXIV (May 1952), Cambridge, Mass. pp. 97-142. 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 1909-60, (BLS Bulletin 1312, 1961).

Combining this employment with on-site employment results in an estimate of 126 man-hours of employment in the construction industry for each $1,000 of public housing construction.

Employment in Transportation, Trade, and Service

Distribution of construction materials from producing industries requires employment of workers in transportation, warehousing, and trade industries. The estimate of 27 hours of primary employment per $1,000 of construction contract is based on the difference between producer's value 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 public housing. It is estimated that 39 man-hours were required for each $1,000 of total construction contract to produce construction materials used in building public 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 below.

Employment in Secondary Activities

In addition to 39 man-hours previously noted for primary employment for each $1,000 of public housing construction contract in factories producing construction materials, an additional 25 man-hours were required in secondary manufacturing activities.

Transportation, trade, and service industries required 27 man-hours to manufacture and transport materials to and from the industries affected indirectly. These industries as a group required 9 man-hours for each $1,000 of construction contract to meet the needs of secondary business activity.

Other business activities, principally agriculture, forestry, and mining, accounted for the remaining 10 man-hours of secondary requirements.

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[9]Included in the bill of materials were supplies and the expended value of construction equipment used by contractors.

Construction Time

Average construction time for the projects surveyed was 58 weeks. Individual projects varied from a low of 30 weeks to a high of 122 weeks. The strongest influence on construction time appeared to be project size. It took an average of 47 weeks for construction of projects in the smallest cost category, while those projects in the largest category required 94 weeks (table 10). Projects constructed of wood appeared to have a shorter average construction time than did reinforced concrete or load-bearing masonry projects of the same size. This may be due to greater use of prefabrication and faster erection of the basic building frame. Construction time for comparable projects was generally shorter in the South, probably because the milder climate permitted construction to continue year round. Average number of weeks required for construction follows:

United States	58
Northeast	78
North Central	85
South	46
West	61

Employment by Construction Periods

In order to measure the distribution of employment, the construction time for each project was divided into 10 equal periods, and data on the number of man-hours worked were tabulated for each of these periods. This permitted the combination of man-hours for projects of various sizes in order to obtain typical employment patterns. The typical pattern is for employment to start slowly, build to a peak in the middle deciles, then taper off towards the end (table 11). There were no radical departures from this pattern, although construction of wood frame buildings came to a faster peak, with 30 percent of total employment in the third and fourth deciles. Reinforced concrete man-hours stayed at a high level later than did those of the other structural types. Chart 3 shows on-site man-hour requirements per $1,000 of construction cost by decile.

Materials Used

Cost of materials (table 12) represented approximately 47.5 percent of total construction cost for all public housing projects surveyed. These costs also include depreciation charges or rental costs for construction equipment, as well as costs of small amounts of supplies consumed and materials or fixed equipment incorporated in structures. About 61 percent of the projects fell within 5 percent of the average for all projects. The percentage of projects within certain ranges is as follows:

Percent materials cost of total construction cost	Percent of projects
40.9 to 44.9	20
45.0 to 49.9	35
50.0 to 54.9	35
55.0 to 57.8	10

The difference between total construction cost and the sum of materials and on-site wage costs for all projects amounted to about 17 percent. This difference represents the total of those overhead costs which cannot be attributed to specific projects--such as administrative off-site salaries, expenses of central office and yard operations, insurance and taxes, plus other overhead, and profit.

Table 13 presents costs of major materials groups by type of structure. Materials cost is expressed in terms of dollars per $1,000 of construction contract expenditure. This may be translated into percentage terms if the reader prefers. For instance, $475 of cost per $1,000 of expenditure is equivalent to 47.5 percent of total construction expenditure. Although materials requirements are expressed as a ratio of cost in the tables, in some ways this is not a true measure of materials requirements. For a project with a given number of dwelling units, materials cost as a percentage of total cost will be affected by whether labor costs are high or low, since labor costs are also a component of the total. Materials requirements are expressed below in terms of cost per 1,000 square feet, so that the element of labor cost will not affect comparisons.

Region	Materials cost per 1,000 square feet
United States	$10,680
Northeast	10,910
North Central	12,250
South	9,360
West	12,900
Type of structure	
Reinforced concrete	11,320
Load-bearing masonry	9,620
Wood	10,120

Table 10. Average Number of Weeks Required for Construction of Public Housing Projects, by Selected Characteristics and Region, 1959-60[1]

Characteristic	United States	South	Other regions[2]
All projects	58	46	78
Construction cost group:			
Under $1,000,000	47	43	60
$1,000,000-$1,999,999	73	61	90
$2,000,000 and over	94	64	102
Type of structure:[3]			
Reinforced concrete	84	--	84
Load-bearing masonry	54	48	76
Wood	46	42	58

[1]Although construction on some projects extended into 1961, most construction was performed in 1959-60.

[2]Insufficient data to warrant separate presentation by characteristics for the other three regions.

[3]Does not include two projects having a mixture of different types of structures.

Table 11. Percent of On-Site Employment for Public Housing Construction in Each Tenth of Total Construction Time, by Region and Type of Structure, 1959-60[1]

Region and type of structure	Percent of on-site man-hours in--									
	First tenth	Second tenth	Third tenth	Fourth tenth	Fifth tenth	Sixth tenth	Seventh tenth	Eighth tenth	Ninth tenth	Last tenth
Region										
United States	3.6	8.7	12.0	13.2	13.8	14.0	12.4	10.5	7.5	4.3
Northeast	4.1	7.7	9.9	11.7	13.9	13.5	13.2	12.4	9.1	4.6
North Central	3.6	8.2	12.4	13.5	13.8	16.7	14.3	10.3	5.4	1.8
South	3.5	9.7	13.4	14.2	13.5	13.1	10.7	9.1	7.3	5.4
West	2.7	8.7	11.5	13.5	15.5	14.9	13.7	11.1	5.9	2.4
Type of structure:[2]										
Reinforced concrete	3.6	7.1	10.4	12.0	13.7	14.6	13.6	12.3	8.5	4.1
Load-bearing masonry	3.3	8.4	11.5	14.0	14.3	14.0	12.5	9.8	7.4	4.8
Wood	4.9	12.5	16.7	14.4	12.0	10.6	8.5	8.7	6.2	5.4

[1]Although construction on some projects extended into 1961, most construction was performed in 1959-60.
[2]Does not include two projects having a mixture of different types of structures.

Note: Because of rounding, sums of individual items may not equal 100.0.

Chart 3. Percent of On-Site Man-Hours Worked in Each Decile of Construction Time, 1959-60

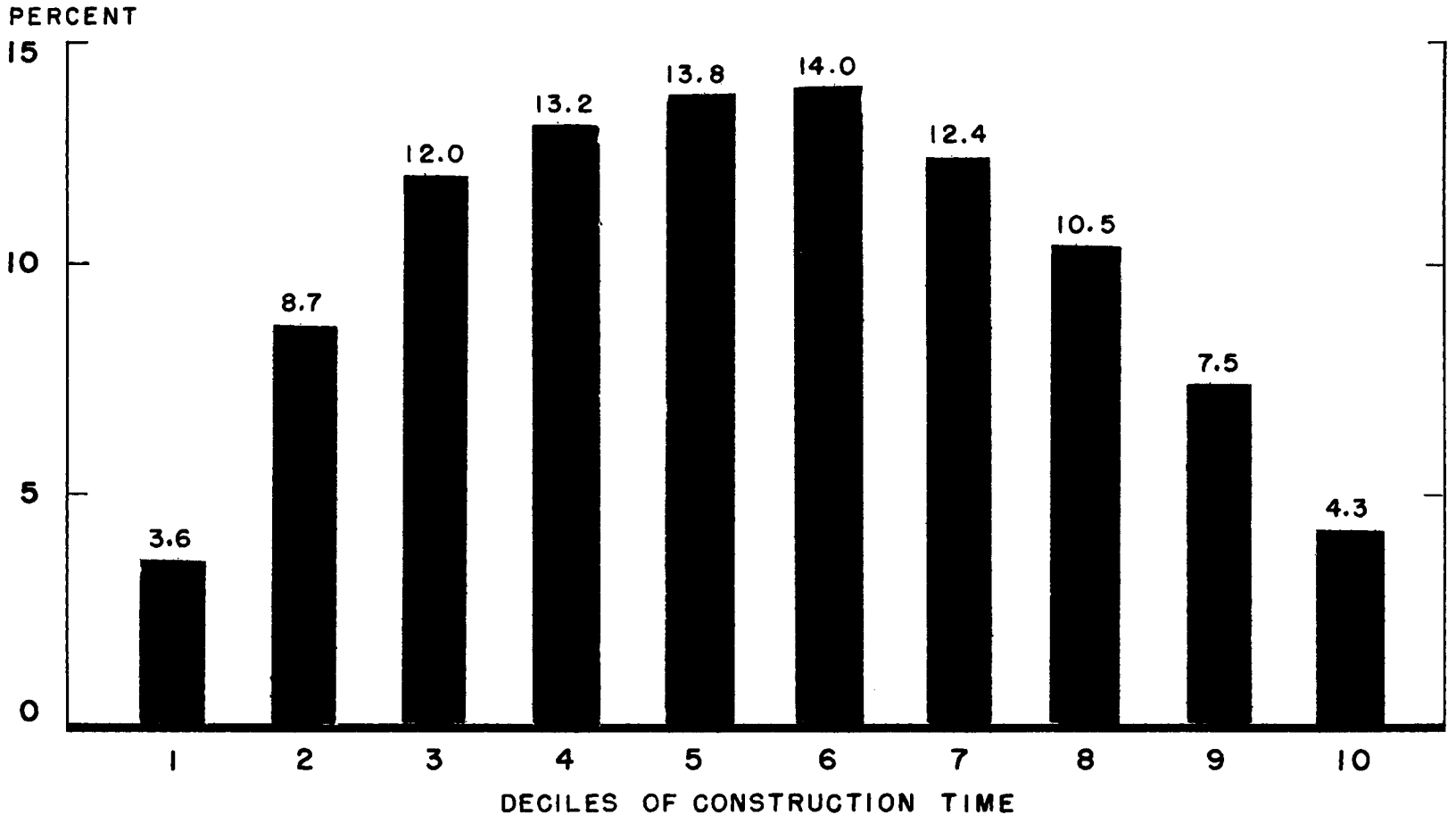

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Table 12. Cost of Materials per $1,000 of Public Housing Construction Contract, by Type of Material and Region, 1959-60[1]

Selected products and product groups	United States	North-east	North Central	South	West
Total cost, all products	$475.00	$445.70	$460.00	$506.70	$513.30
Stone, clay, and glass products	$132.50	$118.80	$116.60	$155.10	$138.60
Cement, concrete, and gypsum products	84.90	74.20	69.70	98.50	110.50
Ready-mix concrete	47.50	47.00	47.20	43.60	64.30
Gypsum products	14.90	12.50	10.80	17.60	23.30
Concrete block and brick	11.40	7.20	3.70	21.60	7.10
Cement	5.10	4.00	5.00	5.60	8.40
Concrete pipe	2.40	1.30	(2/)	4.90	1.90
Precast concrete products	1.90	.60	.80	3.00	5.00
Lime	1.70	1.50	1.90	2.20	(2/)
Structural clay products	28.30	28.70	31.50	31.50	8.50
Brick and structural clay tile	22.70	25.40	26.00	23.60	1.00
Clay sewer pipe	2.20	.90	5.10	1.90	2.80
Ceramic tile	1.70	1.00	(2/)	3.20	1.00
Other stone, clay, and glass products	19.30	16.00	15.50	25.00	19.60
Asphalt tile	5.20	6.00	4.50	5.20	4.00
Sand and gravel	3.70	1.40	3.20	6.30	4.80
Fiber glass insulation (including acoustical tile)	3.10	4.20	2.70	2.90	.50
Window glass	2.80	2.50	2.40	3.40	3.20
Crushed rock, slag, and miscellaneous aggregate	2.60	1.20	1.90	4.20	4.00

See footnotes at end of table.

Table 12. Cost of Materials per $1,000 of Public Housing Construction Contract, by Type of Material and Region, 1959-60[1]--Continued

Selected products and product groups	United States	North-east	North Central	South	West
Metal products (except plumbing and heating)	$108.40	$119.20	$114.70	$97.60	$90.80
Fabricated structural metal products	80.20	95.80	84.80	66.20	57.40
Reinforcing bars, rods, and joists	28.70	42.70	31.30	13.70	23.10
Metal windows, frames, and accessories	15.10	14.40	14.60	17.90	8.80
Ornamental metal	8.60	12.40	5.20	7.90	2.50
Metal doors, frames, and accessories	7.90	8.50	6.60	8.10	7.80
Fabricated sheet metal, formed metal roof, and floor decks and metal forms	7.20	5.90	6.50	8.10	10.30
Metal lath	5.80	9.20	4.00	4.10	1.30
Structural steel	2.70	1.80	1.90	4.50	1.40
Wire mesh	2.10	.90	4.20	2.30	2.30
Other metal products	17.50	13.20	23.30	19.80	15.30
Copper (sheet metal and pipe)	10.50	10.20	10.10	11.20	10.40
Nails	2.40	1.70	1.70	3.50	2.80
Galvanized sheet metal	1.90	.90	2.70	2.70	1.70
Metal case work	1.60	(2/)	7.60	.50	(2/)
Other fabricated metal products	10.70	10.10	6.60	11.60	18.10
Builder's hardware	10.60	10.10	6.60	11.40	18.10
Lumber and lumber products	67.20	50.70	53.20	85.60	96.40
Rough and dressed lumber	26.60	19.60	14.30	35.10	49.40
Millwork	26.10	24.90	16.50	28.80	40.80
Fabricated structural laminates	8.60	1.20	18.20	13.20	3.50
Plywood	5.00	3.40	3.90	8.30	2.20

See footnotes at end of table.

Table 12. Cost of Materials per $1,000 of Public Housing Construction Contract, by Type of Material and Region, 1959-60[1]--Continued

Selected products and product groups	United States	North-east	North Central	South	West
Plumbing products	$47.70	$44.50	$48.20	$51.30	$46.70
Fixtures	17.40	15.30	13.90	22.00	15.30
Steel and galvanized pipe	11.70	10.50	13.60	11.60	12.90
Cast-iron pipe	9.90	11.30	7.70	8.90	12.60
Valves and specialties	8.00	6.60	12.70	8.10	4.50
Fixed house equipment	28.80	36.40	32.70	19.90	22.70
Refrigerators	10.20	8.70	10.40	12.00	9.80
Elevators and moving stairs	9.90	19.40	11.10	(2/)	4.10
Ranges	5.80	4.50	7.10	6.40	6.20
Venetian blinds	1.50	1.10	2.40	1.50	1.80
Electrical equipment, fixtures, and wire	22.80	23.00	25.40	19.00	30.90
Conduit	5.90	5.90	7.00	4.50	8.60
Lighting fixtures	4.00	3.50	5.30	3.30	6.20
Switchboards and panels	3.60	3.90	4.40	2.20	5.40
Wire and cable	3.40	3.10	3.10	3.80	3.30
Other noncurrent-carrying wire devices	2.10	1.80	1.30	2.60	2.60
Current-carrying wiring devices	1.60	1.50	1.30	1.30	3.50
Electricity generating units	1.30	2.60	1.40	(2/)	(2/)
Heating, ventilating, and air-conditioning equipment	17.30	18.50	28.80	11.90	9.40
Radiators, convectors, boilers, and hot water tanks	7.60	11.00	11.50	2.90	2.50
Unit heaters and ventilators	2.90	(2/)	.80	7.90	.60
Storage tanks	1.80	2.90	2.70	.60	(2/)
Warm air furnaces	1.70	.60	5.40	(2/)	4.90
Pumps	1.10	1.20	3.00	(2/)	(2/)

See footnotes at end of table.

Table 12. Cost of Materials per $1,000 of Public Housing Construction Contract, by Type of Material and Region, 1959-60[1]--Continued

Selected products and product groups	United States	North-east	North Central	South	West
Paints and other chemical compounds	$8.60	$6.10	$9.20	$11.10	$9.50
Paint	6.00	4.30	7.00	7.00	7.20
Putty, caulking, and glazing products	.90	.70	1.20	1.10	.60
Petroleum products	5.40	3.50	2.80	8.90	5.40
Asphalt paving	2.40	1.10	.80	4.70	2.40
Asphalt and tar pitches	1.20	1.30	.60	1.50	.90
Asphalt felts	1.10	.90	.30	1.80	1.00
All other	11.10	6.90	6.80	18.80	9.70
Nursery products	5.10	5.00	2.60	6.60	4.90
Asphalt shingles	2.60	(2/)	.80	7.20	(2/)
Construction equipment rental value or depreciation charge	25.20	18.20	21.60	27.50	53.10

[1]Although construction on some projects extended into 1961, most construction was performed in 1959-60.

[2]Less than $0.50.

Note: Group totals include value of products not shown separately. Values were rounded to the nearest tenth of one dollar.

Table 13. Cost of Materials per $1,000 of Public Housing Construction Contract, by Major Materials Group and Type of Structure, 1959-60[1]

Materials group	Reinforced concrete	Load-bearing masonry	Wood
Total cost, all products	$442.10	$501.30	$504.90
Stone, clay, and glass products	$123.50	$151.80	$127.50
Cement, concrete, and gypsum products	76.60	98.40	77.00
Structural clay products	33.50	27.30	28.70
Other stone, clay, and glass products	13.40	26.10	21.80
Metal products (except plumbing and heating)	124.60	96.70	83.00
Fabricated metal products	100.20	65.70	47.30
Other metal products	15.00	19.30	21.00
Other fabricated metal products	9.40	11.70	14.70
Lumber and lumber products	32.30	90.30	117.40
Plumbing products	47.70	46.00	51.20
Fixed house equipment	39.40	19.30	21.10
Electrical equipment, fixtures and wire	24.90	20.90	18.80
Heating, ventilating, and air-conditioning equipment	19.40	14.10	15.20
Paints and other chemical compounds	5.90	10.20	10.50
Petroleum products	3.00	8.60	7.50
All other	4.50	13.90	26.40
Construction equipment	18.50	24.20	32.80

[1]Although construction on some projects extended into 1961, most construction was performed in 1959-60.

Costs appear higher in the North Central and Western regions. A possible reason for this is greater distance from major sources of supply for some materials, with consequent higher transportation costs. However, there may be other reasons, such as architectural design variations, which cannot be identified from the data at hand.

Although there is little difference in total materials requirements, variations in the amount spent on subgroups and individual products are quite pronounced for the different structural types. The four most important product groups are stone, clay, and glass products; metal products; lumber and lumber products; and plumbing products. On the average, these four groups account for 75 percent of total materials costs.

Stone, clay, and glass products accounted for about 28 percent of materials cost. Load-bearing masonry structures had higher costs for these products, because of greater expenditures for concrete block and brick. Expenditures for this product group were higher in the South because of the preponderance of load-bearing masonry structures located there. The West had higher costs in this category, particularly for cement.

The metal products group, next largest, comprised 23 percent of total materials cost. Reinforced concrete structures had the greatest expenditures for metal products. This was due to high expenditures for fabricated metal products, particularly the reinforcing rods, bars, and joists which this type of structure requires. This materials grouping does not represent the total contribution of metalworking industries, since metal products shown separately in equipment categories are not included here.

Lumber and lumber products, the third largest category, amounted to 14 percent of total materials cost. Not surprisingly, wood structures had the highest expenditures for lumber products. Reinforced concrete structures had low expenditures in this category, less than one-third as much as wood. Regional variations are also interesting. High expenditures for lumber in the West were probably encouraged by nearness of lumber mills and other supply sources. Low expenditures in the Northeast and North Central regions are influenced both by greater distance from supply sources, and by the fact that the dominate structural types built, reinforced concrete and load-bearing masonry, do not require as much lumber.

Plumbing products accounted for 10 percent of total material expenditures. There was very little variation by region or structural type. Apparently expenditures for plumbing products are more or less a fixed factor in public housing construction.

Remaining product categories will not be discussed in detail, but some of the more interesting relationships can be noted. Expenditures for heating and ventilating products, for example, are higher in the Northeast and North Central regions because of more severe climatic conditions than in the South. Some of the expenditures for heating equipment, such as ducts, are also included under fabricated sheet-metal products, or under galvanized sheet-metal products. Expenditures for fixed house equipment are higher for reinforced concrete buildings because these buildings have elevators or escalators and the other types do not.

In summary, each structural type has a particular "mix" of product expenditures associated with it. In some product categories, such as plumbing products, there is no great difference between different structural types; in other categories, such as lumber and lumber products, the variation is considerable. Reinforced concrete structures have high requirements for metal products and fixed house equipment. Load-bearing masonry structures have high requirements for stone, clay, and glass products; wood structures have high requirements for lumber and lumber products.

Materials requirements vary from region to region because of differences in the kind of structural types being built, the cost and availability of materials, and other factors such as climate.

Appendix. Scope and Method of Survey

This study, designed to develop estimates of man-hour requirements associated with construction of public 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. Public housing projects which were not federally aided were not included in this study.

Characteristics of the Universe and Selection of the Sample

A complete listing of all public housing projects administered by the Public Housing Administration, as of June 30, 1960, was secured. This publication, titled Consolidated Development Directory (Report S-11A), indicates location, number of dwelling units, construction starting dates, and other pertinent data for all projects as of that date. The universe for sampling purposes consisted of all projects (approximately 130 containing about 14,000 dwelling units) on which construction was indicated as having been started during 1959. These projects were stratified by four broad geographical regions described previously under Nature of the Survey and by number of dwelling units in each project.

A sample of 31 projects, approximately 1 in 4 of the universe, was selected. As sampling within cells was not uniform owing to the number of projects within some cells, variable weights were assigned to projects. Unless otherwise noted, all information presented in this report is based on weighted data. Although construction on some projects extended into 1961, most construction on projects studied took place during 1959 and 1960.

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, with 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 companies, plus all trade, distribution, and services involved in placing construction materials at the 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. 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

Under the U.S. Housing Act of 1937, as amended, the Public Housing Administration is responsible for administering the low-rent public housing program. The act provides for a program of locally owned and operated low-rent public housing under which local governments, pursuant to State enabling legislation, establish independent legal entities (local housing authorities) to develop, own, and operate the housing projects. PHA provided financial and technical assistance through 1962 to about 1,370 local housing authorities for development of housing projects. It reviews administration of projects after construction is completed to determine that they are operated and maintained in a manner to promote serviceability, efficiency, economy, and stability and that the low-rent character of the projects is maintained.

When a public housing project is constructed with Federal assistance, each prime contractor and subcontractor engaged on the project is required by legislation to submit to local housing authorities a copy of each weekly payroll showing (with other information) daily and weekly hours worked, the gross weekly earnings, and the occupation of each of his employees working on the particular project. Through the cooperation of the Federal Housing Administration and local housing authorities of the several States, copies of payrolls for projects included in the sample, along with lists of contractors working on the projects, were made available to the Bureau. These payrolls provided data for estimating 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, 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 price list was obtained of the value of each type of material used in construction of sample projects. These material listings were classified into categories consistent with 4-digit Census of Manufactures product groups. For each of these product groups, average amounts required per $ 1,000 of contract construction 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.[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 each construction material and equipment, a newly prepared 200-interindustry system of classification was used which incorporated a 200-order interindustry system of classification, replacing the previous 57-order interindustry analysis. The 200-order interindustry analysis, while principally based on the 1947 interindustry analysis, is now adjusted to 1960 prices and productivity levels. The newly prepared 200-interindustry system is also constructed on a six-sector determination of associated employment needed to produce a given bill of goods. Each of the six sectors--agriculture, mining, manufacturing, transportation, trade, and all other--has an individual employment factor for each product group. By multiplying the value of each component by the six individual employment factors, it was possible to determine amount of employment required in the six sectors to produce each given material. Price adjustments and productivity adjustments 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 public 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, procedures used in estimating employment generated by public housing construction did not include all such employment. Techniques used for the off-site segment cover only employment generated by direct purchases of materials and supplies and implicit in 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) the labor time involved in

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[10]The ratio used for this reduction was the purchaser-to-producer ratio for these components in new construction as developed for use in the 1947 study of the industrial interrelationships of the American economy.

[11]This ratio was established by using the 1959 Survey of Manufactures.

installations by public utility employees, as well as any site preparation not covered by the construction contract; (4) employment generated by purchases of moveable furniture and equipment; (5) the "multiplier" effect of respending of wages and profits; and (6) construction and equipment of production facilities, if needed to supply construction materials.

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