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Volume Title: Recent Economic Changes in the United States, Volumes 1 and 2

Volume Author/Editor: Committee on Recent Economic Changes of the President's Conference on Unemployment

Volume Publisher: NBER

Volume ISBN: 0-87014-012-4

Volume URL: <http://www.nber.org/books/comm29-1>

Publication Date: 1929

Chapter Title: Construction

Chapter Author: John Gries

Chapter URL: <http://www.nber.org/chapters/c4956>

Chapter pages in book: (p. 219 - 254)

CHAPTER III

CONSTRUCTION

BY JOHN M. GRIES

I. CONSTRUCTION AND GENERAL ECONOMIC CONDITIONS, 1919-1928

The record-breaking volume of construction has been of profound importance to the American people. The business sections of cities have been transformed by the increasing erection of great buildings. Hundreds of thousands of miles of roads and streets have been improved and co-ordinated to meet the needs of 25 million automobiles. Suburban areas have spread out faster than ever before, built up with modern and more attractive dwellings, while at the same time apartment houses have become a more important factor in housing. The public utilities, furnishing the "roots" which bring to buildings light and power, running water, and communication, have been expanded more rapidly than ever before, and our industries have acquired vastly improved plants with which to work. And this program of construction, recently amounting to more than \$7,000,000,000¹ annually, has been carried on, during the

¹ *Statistics Relating to Value and Volume of Construction.*—The statement that construction has amounted, in round figures, to over \$7,000,000,000 annually is derived by assuming that the per-capita construction in states for which the F. W. Dodge Corporation does not report contracts awarded is not greatly different from that in the remainder of the country. No attempt is made in this paper to estimate the value of small buildings and work of certain types not reported by the F. W. Dodge Corporation, which might raise the total by a billion to a billion and a half or more dollars, nor to deduct from such an estimate various items included in the total cost of building projects which might not properly fall under common definitions of construction.

The F. W. Dodge Corporation figures on contracts awarded are shown in accompanying tables as the most comprehensive available. The tables also show building permit statistics as classified by the Department of Labor and other agencies; reports on contracts awarded for public works, public utilities, and large buildings compiled by the *Engineering News-Record*; census reports on the financial statistics of cities; reports by the Bureau of Public Roads; and census, railway, and other data relating to the production and shipments of building materials.

The tables are presented, in the absence of any more satisfactory data, simply to give readers a general idea of the relative values of the different classes of construction, and of the fluctuations from year to year by classes of construction and geographic regions. There is no general index of construction employment. The data as to contracts awarded and building permits are similar to data on new orders in some other industries.

TABLE 1.—CONSTRUCTION CONTRACTS AWARDED, BY CLASSES

NOTE.—The value of military and naval buildings for 36 states in 1927 was \$8,855,200 and the floor space amounted to 1,742,700 square feet; in 1928 the value was \$14,527,500 and floor space was 3,578,700 square feet.
(Values in millions and tenths of millions of dollars; floor space in thousands of square feet)

Year	Total	Residential	Commercial	Industrial	Public works and utilities	Educational	Hospitals and institutions	Public buildings	Religious and memorial	Social and recreational
27 STATES										
Value of construction:										
1919	2,579.9	849.2	405.7	512.9	502.0	119.5	39.2	13.4	37.5	83.6
1920	2,533.2	566.1	419.7	589.0	566.3	172.3	47.5	26.6	41.4	91.1
1921	2,360.2	877.9	338.0	173.3	459.4	243.7	70.1	22.3	60.4	108.8
1922	3,352.7	1,347.2	496.3	325.0	562.2	303.3	86.6	32.4	86.1	110.0
1923	3,494.1	1,582.8	446.1	378.8	557.4	272.5	62.0	19.2	72.0	100.3
1924	3,879.5	1,842.5	522.2	285.1	577.3	317.1	98.3	28.6	96.3	109.8
1925	5,043.0	2,359.9	717.3	413.3	704.1	369.5	97.6	35.3	124.7	216.2
1926	5,421.7	2,338.8	784.1	592.3	861.3	321.1	120.8	44.3	127.9	223.5
1927	5,473.1	2,326.9	834.4	376.8	1,025.4	323.8	149.0	56.8	132.3	239.8
1928	5,843.9	2,551.2	785.3	506.1	1,133.3	347.2	153.7	50.7	109.0	194.5
Floor space of buildings:										
1919	560,219	241,880	110,884	153,268	.....	22,979	6,821	2,066	5,334	15,175
1920	401,794	137,524	82,434	127,830	.....	26,278	6,277	2,732	5,083	12,360
1921	387,229	204,575	65,235	35,771	.....	40,583	10,683	3,056	9,201	17,466
1922	573,856	311,407	95,233	65,550	.....	54,592	11,779	3,382	12,857	18,216
1923	591,976	354,257	92,788	62,205	.....	44,332	9,997	3,123	9,284	15,435
1924	600,916	371,068	95,861	40,967	.....	46,875	12,707	4,451	11,960	16,484
1925	762,146	470,207	124,064	58,719	.....	51,204	12,020	4,703	13,814	26,476
1926	741,270	450,249	121,039	67,764	.....	44,478	13,131	4,631	13,019	26,166
1927	723,655	434,856	118,940	53,052	.....	45,197	16,967	5,983	13,187	28,974
1928	834,689	507,980	134,206	76,812	.....	52,986	18,183	5,772	12,304	23,211
36 STATES										
Value of construction:										
1923	3,981.3	1,734.5	512.9	443.2	665.5	320.6	78.1	23.3	89.1	110.6
1924	4,485.8	2,050.1	596.3	355.3	723.9	367.4	112.5	35.9	119.1	123.0
1925	5,822.2	2,672.0	835.7	462.7	885.7	413.2	108.5	46.7	148.0	243.6
1926	6,152.0	2,579.3	880.1	677.1	1,068.2	367.1	130.6	54.8	144.5	241.6
1927	6,084.0	2,489.6	897.2	475.6	1,213.3	368.8	158.8	66.1	150.1	255.7
1928	6,404.8	2,715.1	847.6	602.6	1,288.6	386.5	162.0	57.3	122.4	208.2
Floor space of buildings:										
1923	678,565	392,747	109,508	73,421	.....	55,688	12,307	3,806	12,710	17,721
1924	699,320	422,285	113,040	50,033	.....	58,241	15,155	5,492	15,514	19,201
1925	887,550	540,509	151,062	67,478	.....	58,700	13,595	6,703	17,786	30,584
1926	838,430	498,927	142,357	78,790	.....	52,207	14,451	6,127	15,518	28,961
1927	803,546	474,279	133,142	68,904	.....	53,082	18,292	7,429	15,952	31,555
1928	920,903	548,325	150,392	91,538	.....	60,625	19,528	6,887	14,473	25,556

TABLE 2.—INDEX NUMBERS OF BUILDING MATERIAL PRICES AND CONSTRUCTION COST

Year	(1) All com- modity index	(1) Wholesale price indexes of—							(2) Construc- tion costs	(3) Factory bldg. costs	(4) Frame house mate- rials, re- tail prices	(4) Brick house mate- rials, retail prices
		All bldg. materials	Lumber	Brick	Cement	Steel	Paint materials	Other bldg. materials				
1913.....	69.8	56.7	54.0	38.9	59.6	77.1	50.8	63.1	48.1	.....	51.4	51.3
1914.....	68.1	52.7	49.9	38.8	55.0	60.0	50.7	59.7	42.6	50.8	.....	.....
1915.....	69.5	53.5	48.7	39.1	51.0	65.3	54.8	65.1	44.5	.....	.....	.....
1916.....	85.5	67.6	55.1	42.4	65.4	128.9	77.1	87.8	70.9	.....	.....	.....
1917.....	117.5	88.2	72.2	50.2	80.3	190.8	95.3	114.0	87.1	.....	.....	.....
1918.....	131.3	98.6	83.5	66.7	94.6	153.2	121.9	121.0	91.0	.....	.....	.....
1919.....	138.6	115.6	113.0	91.9	102.3	128.7	140.3	116.8	95.4	.....	.....	.....
1920.....	154.4	150.1	165.2	118.4	117.2	144.4	148.1	135.0	120.8	.....	.....	.....
1921.....	97.6	97.4	88.9	105.7	110.8	104.4	83.9	111.1	97.0	90.9	.....	.....
1922.....	96.7	97.3	99.1	99.4	103.5	88.5	93.8	95.3	83.9	86.3	93.3	95.3
1923.....	100.6	108.7	111.8	103.6	107.9	123.7	101.3	105.5	102.9	102.6	106.2	106.9
1924.....	98.1	102.3	99.3	103.4	105.7	114.2	99.7	104.0	103.6	100.5	103.4	104.4
1925.....	103.5	101.7	100.6	100.1	102.6	102.2	109.3	100.4	99.4	99.0	100.5	100.9
1926.....	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1927.....	95.4	93.3	92.5	93.2	96.7	94.7	91.0	94.1	99.1	97.5	96.1	96.5
1928.....	97.7	93.7	90.1	92.7	95.9	95.2	86.6	101.3	99.4	97.0	91.4	93.9

Sources: (1) Department of Labor; (2) Lumber, steel, cement and common labor, *Engineering News-Record*; (3) Standard factory building, Aberthaw Co.; (4) Retail prices of building materials in 45 cities, Department of Commerce.

TABLE 3.—RELATIVE VALUE OF THE SEVERAL CLASSES OF CONSTRUCTION CONTRACTS

Class	Per cent of total value—27 states										Per cent of total value—36 states			
	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1925	1926	1927	1928
Total.....	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Residential.....	32.9	22.3	37.2	40.2	45.3	47.5	46.8	43.5	42.5	43.7	45.9	41.9	40.9	42.5
Commercial.....	15.7	16.6	14.3	14.8	12.8	13.5	14.2	14.4	15.3	13.4	14.4	14.3	14.8	13.2
Industrial.....	19.9	23.3	7.3	9.7	10.8	7.3	8.2	10.9	7.0	8.7	7.9	11.0	7.8	9.4
Public works and utilities.....	19.5	22.4	19.5	16.8	16.0	14.9	14.0	15.8	18.7	19.4	15.2	17.4	19.9	20.1
Educational.....	4.6	6.8	10.3	9.0	7.8	8.2	7.3	5.9	5.9	5.9	7.1	6.0	6.1	6.0
Hospitals and institutions.....	1.5	1.9	3.0	2.6	1.8	2.5	1.9	2.2	2.7	2.6	1.9	2.1	2.6	2.5
Public buildings.....	0.5	1.1	0.9	1.0	0.5	0.7	0.7	0.8	1.0	0.9	0.8	0.9	1.1	0.9
Religious and memorial.....	1.5	1.6	2.6	2.6	2.1	2.5	2.5	2.3	2.4	1.9	2.5	2.4	2.5	1.9
Social and recreational.....	3.2	3.6	4.6	3.3	2.9	2.8	4.3	4.1	4.4	3.3	4.2	3.9	4.2	3.3
Military and naval buildings.....	0.7	0.5	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2

Sources: Division of Statistical Research, Bureau of Foreign and Domestic Commerce, based on data furnished by the F. W. Dodge Corporation.

TABLE 4.—TOTAL BUILDING CONTRACTS AWARDED, BY FEDERAL RESERVE DISTRICTS
(In thousands of dollars)

District	1919	1920	1921	1922	1923	1924	1925	1926	1927
Total ^a	2,370,529	2,320,577	2,157,277	3,003,155	3,972,084	4,458,942	6,007,305	6,384,406	6,303,056
First (Boston).....	222,057	285,529	193,747	317,639	311,344	332,018	453,409	417,546	389,139
Second (New York).....	560,299	595,442	654,062	919,380	1,088,980	1,356,300	1,625,101	1,799,099	1,708,074
Third (Philadelphia).....	238,080	176,946	179,037	254,171	228,115	327,678	360,710	418,719	487,217
Fourth (Cleveland).....	413,553	401,920	353,334	473,109	503,027	503,923	709,827	651,376	673,354
Fifth (Richmond).....	185,351	154,662	207,620	267,745	295,193	311,020	399,291	439,571	409,011
Sixth (Atlanta).....	.....	.....	.....	.....	304,592	388,392	570,526	521,366	380,771
Seventh (Chicago).....	659,514	596,100	471,264	677,462	691,281	730,216	1,044,137	1,162,560	1,288,332
Eighth (St. Louis).....	.....	.....	.....	.....	277,187	293,426	372,048	392,029	401,799
Ninth (Minneapolis).....	91,676	109,978	98,212	93,651	144,432	102,387	113,011	123,678	110,122
Tenth (Kansas City).....	.....	.....	.....	.....	127,931	113,581	150,737	197,378	212,369
Eleventh (Dallas).....	.....	.....	.....	.....	.....	(^b)	208,508	261,083	242,869

^a For the districts for which figures are shown.

^b Contracts awarded in the Eleventh District during the eight months, May to December, 1924, valued at \$142,163,000, are not included in the total.

Source: F. W. Dodge Corporation and Federal Reserve Board.

last seven years, in such a way as to help stabilize and act as a tonic on general business conditions.

The shortage of buildings resulting from the dislocation of construction programs during the World War led to a program of construction in 1919 and 1920 which was speeded up and pressed forward in the face of cost inflation. This contributed to the unhealthy business boom and the precipitate recession which followed.

The rapid falling off of new building during the latter part of 1920 demonstrated the uncertainty which may hang over the industry. Owing to the large number of structures already in use, a decline even of 20 or 30 per cent in one year's new building may not have much effect on the total supply of structures. When the business outlook is uncertain, or when their income is reduced, many owners may postpone building for a year or more, without great hardship to themselves. But a much smaller decrease than 20 per cent may seriously disturb employment conditions among upward of one and a half million workers in the building trades, and perhaps as many more workers in other industries allied with construction.

The prosperity of hundreds of communities depends upon the amount of building materials called for, including lumber and millwork, structural steel, cement, brick, sand and gravel, tile and other clay products, lime, nails, sheet metal, plumbing and heating equipment and fixtures, electrical supplies, paints and varnish, glass, building paper, and roofing materials. These and other building materials, in crude or finished form, represent more than one-eighth of all railway freight tonnage, and it is obvious that even a 5 or 10 per cent reduction in shipments will cut rather seriously into the earnings of the railways and of their employees.

With such facts in mind, the President's Conference on Unemployment, in October, 1921, concluded that "a return of confidence in values in construction will assure more employment than in any other field of industry. Considering all branches of the industry, more than 2,000,000 people could be employed if construction would be resumed." The active building which has continued since has been an energizing force in business, especially in the recovery in 1922, and in 1924 and 1927, when recessions took place in other lines.

Only once since 1920 has there appeared serious danger of an inflationary boom. In the spring of 1923, new construction was being projected so rapidly that wholesale building material prices rose 10 per cent in four months. The Secretary of Commerce, in March, 1923, in reply to a request from the President, suggested that all Federal Government building not urgently required by public necessity be deferred for the time being. In April the report of the Committee on Business Cycles

and Unemployment advised against pressing on with building activity at times when it would involve rapid bidding up of prices for materials and labor, and the problem was widely discussed in trade papers. The building program was safely accommodated to the capacity of the industry, and building costs² have never since been so high.

The comparative stability in total volume of construction has not meant an equal stability for each type of construction, or for individual cities or regions. The number of homes built and the total floor space of all buildings for which contracts were awarded was higher in 1925 than in 1926 or 1927, and the falling off in such work was reflected in smaller shipments of various building materials and some lessening in the demand for building-trades workers. The increase in public works and utilities construction, however, led to greater production of some other materials, such as cement, sand, and gravel, and involved a shift in types of labor employed. Even in the period since 1925, new building undertaken in some of the largest cities has fallen off from 15 to 20 per cent, or even more, from one year to the next. Similar fluctuations have been noted between areas embraced in different Federal Reserve districts.

Trends Affecting Stability.—From the national point of view, it is important to throw light on whether the relatively stable national totals have been owing primarily to chance or coincidence, and how far underlying forces have been developed which have helped to keep the national totals from fluctuating materially.

A complete analysis would involve discussing the major elements of business conditions for several decades, but only certain principal changes are mentioned here. It is assumed that the amount of construction carried on at a given time is not entirely dependent upon what is happening in other lines, and that it is not the single dominant factor in the business situation. It is one very important factor, subject in some measure to other influences, and at the same time it reacts intimately upon other lines.

*Changes Relating to the Demand for Construction.*³—The nature of the basic factors in the demand for construction, and the immediate stimuli which occasion various classes of projects, must both be considered.

² The indexes of building material prices may be considered fairly satisfactory so far as they go, although they are not weighted yearly for fluctuations in the character of construction. Most of the building cost indexes are "synthetic," rather than based on actual records, and assume a fixed quantity of labor and materials. They do not take into account such factors as variation between published and actual wage rates, the efficiency of labor, improved design, labor-saving equipment, savings to the owner due to decreased time of construction, and competitive conditions which may affect the profit which contractors are willing to accept.

³ See *Seasonal Stabilization*, Chap. V, Marketing, p. 343; Chap. VI, Labor, p. 482; Chap. VII, Management, p. 503; Chap. IX, Price Movements, p. 613.

Assuming that living standards do not decline, the 1,600,000 or 1,700,000 additional inhabitants each year call for an annual addition of about 400,000 homes, with other types of structures roughly in proportion. As has been shown in the first chapter, the annual increase in population has become much more nearly stabilized under the operation of the restrictive immigration acts.

The net loss of farm population to cities and towns has resulted in an unusual demand for urban dwellings.

The razing or abandonment of buildings on account of fire, physical deterioration which makes them unfit for use, or for other cause, probably has not changed much as a factor.

The growth in per capita income during the postwar period has been reflected in a demand for improved dwellings and structures of various types, including places of work and recreation. Coupled with advancement in the design and equipment of buildings, obsolescence of existing structures has had an important effect. Larger incomes have meant an increase in number of automobiles, a greater demand for highway construction, and the building of garages and service stations. The motion picture industry has grown with the motion picture theater, made more accessible by automobiles and improved roads. Recognition of better standards of working conditions in offices and factories has brought improved construction. Greatly enlarged attendance at schools and colleges has resulted in vast additions to educational buildings.

Increased construction programs are thus bound up with increased productivity in other lines of industry, and with trends in family life and expenditures which are made possible by larger incomes.

Increased savings have permitted enlarged construction programs to meet enlarged demand, and at the same time have stimulated construction projects as profitable investments.

Various outstanding construction projects of a public or semipublic character have occasioned much construction of other types. By cutting through new or wider streets, or by electrification of railway terminals, desirable sites made available in the central business districts of cities have been covered by large modern buildings. The many new vehicular bridges and tunnels inevitably result in changed use of land in various districts, and have led to much new building.

Supply of Investment Funds.—During the period between the Civil War and the World War the savings funds of the nation were not always adequate for its capital requirements, and the demand for funds with which to carry on construction tended to press upon the supply. When unusually large amounts were borrowed abroad, and there was an enlarged demand upon the physical capacity of the country to produce materials, furnish transportation, and supply labor, construction costs usually went up.

During the past ten years the relation of domestic investment funds to construction has been reversed because the United States has become a lending nation, more than able, from the point of view of total savings, to finance its own needs of domestic capital. The pressure comes from funds seeking employment, rather than from construction projects deferred for want of capital.

One corollary of this is that large construction programs are less apt physically to overtax the nation's productive capacity. In 1923 there was a logical coincidence between the small net amount of lending abroad, the expansion in imports and small margin of exports, and, on the other hand, the large expansion of new construction with a sharp upturn of building material prices and building-trades wages, indicating a scarcity of building-trades labor. Since 1923 the productive capacity of the building material industries, the adequacy of the railways in transporting materials, and of the labor supply to carry on construction have proved sufficient.

Interest Rates.—The lower trend of interest rates has been favorable to construction. Considering the present worth of interest payments made over a period of years, a decrease of 1 or 2 per cent in the rate at which funds are borrowed reduces the first cost of the building by a much larger percentage. Probably of more importance, higher long-term interest rates usually indicate competition for the use of funds, and some classes of builders have to defer building because they cannot borrow through ordinary channels. In the year 1921, for example, although commercial credits were being curtailed and interest rates were falling, local savings banks and building and loan associations commonly were short of funds to lend on mortgages.

Organization of Building Finance.—Steady progress has been made toward systematizing the financing of the nation's building program, and toward national pooling of part of the funds. Of the \$5,000,000,000 worth of private construction carried on annually, probably a greater proportion than formerly is now handled by means of building and loan associations, life insurance companies, savings banks, and other banking institutions, and less by personal transactions between the building owner and the lender. The increased rate of growth in building and loan associations and the passage of the McFadden Act in 1927, which permitted national banks to invest as much as one-half of their savings deposits in realty loans for periods up to five years, have been notable. Financing of large apartments, hotels, and office buildings, by means of mortgage bond issues, which have averaged more than \$300,000,000 annually for several years, is largely a development of the postwar period. Corporations have the national investment security market more readily at their disposal for financing capital expenditures. Exemption from Federal income taxes of interest on local government securities

has enabled local governments since the war to finance at lower rates public buildings and works, amounting to more than \$1,500,000,000 annually.

The net result of all these tendencies is that communities in which there is an immediate demand for new construction can call more readily on national sources for investment funds.

Rents and Vacancies.—Rents and vacancies, two related factors, affect the amount of construction of apartments, hotels, office buildings, and dwellings. Immediately after the World War there was a general shortage of such buildings, vacancies were abnormally low, and rents were rising. But the response to these conditions was decidedly uneven.

Local Conditions.—The total amount of construction in a city or region depends upon many local factors, such as the prosperity and rate of growth of its industries and local rents and vacancies. The peaks in building in Southern California in 1923, in Florida and Philadelphia in 1925, in New York in 1926, and in a number of smaller cities in 1927 illustrate these tendencies.

Conditions Affecting Various Classes of Construction.—Obviously different classes of construction are subject to different influences. Some types of industrial buildings showed an increase in 1921, in spite of the prevailing drastic declines in most other lines. Single family houses, apartments, and hotels have shown many differences in movement. Public works and utilities construction, after an initial spurt in 1919, was slower than other types in getting under way after the war, but has increased more steadily in amount than most other important types of building since that time.

General Business Conditions.—General business conditions have exerted a strong influence on the amount of new industrial building, which fell off strikingly in 1924 and 1927. Some of the other public utilities and public works construction, of which roads are the principal element, have been but little subject to the fluctuations in business conditions since 1923. How far they would be subject to major economic disturbances, or whether or not distinct changes may develop in their secular trend, are other questions.

Although a severe business depression undoubtedly would reduce the amount of building in most localities, the fact remains that abundant credits have not resulted in an inflationary building boom—a frequent precursor to a depression. More mobile capital funds, adequate supplies of building materials, and dependable transportation have made it possible for cities or regions to carry on an unusually large amount of construction without cost inflation, and local recessions in building have ordinarily followed from local conditions other than inflated costs, or insufficient capital funds.

Developments in the commercial banking field might at some time withdraw enough funds from the investment field to retard, for a time at least, building throughout the country.

TABLE 5.—INDEX NUMBERS RELATING TO VOLUME OF CONSTRUCTION AND CONSTRUCTION MATERIALS
(1923 = 100)

Items	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
RELATING PRIMARILY TO TOTAL CONSTRUCTION										
Construction contracts awarded:										
36 states, value.....					100	112.7	146.2	154.5	152.8	160.9
36 states, floor space.....					100	102.9	130.8	123.4	118.3	135.7
27 states, value.....	73.8	72.5	67.5	95.7	100	111.1	144.2	155.0	156.6	167.0
27 states, floor space.....	94.5	67.9	65.4	96.9	100	101.5	128.8	125.2	122.1	141.0
Building permits—168 cities, value.....		46.2	53.6	82.0	100	103.8	122.0	114.9	101.8	99.3
Portland cement, shipments.....	63.3	70.6	69.9	85.8	100	107.3	115.3	119.0	125.8	127.9
Fabricated structural steel.....	80.3	84.3	55.7	105.8	100	120.3	138.3	127.9	132.4	°
RELATING PRIMARILY TO HOUSING										
Residential construction, contracts awarded:										
36 states, value.....					100	118.1	153.9	148.5	143.6	156.5
36 states, floor space.....					100	107.3	137.5	126.9	120.5	139.6
27 states, value.....	53.7	35.8	55.4	85.1	100	116.4	149.1	147.8	147.0	161.2
27 states, floor space.....	68.3	38.8	57.7	87.9	100	104.8	132.7	127.1	122.7	143.4
Number of families accommodated (based on permits).....			49.5	83.2	100	97.6	108.3	102.0	89.5	°
Baths, shipments.....	38.3	56.9	45.9	82.8	100	105.4	122.2	110.2	104.4	102.8

° Not available.

Sources: Construction contracts awarded, from reports of the F. W. Dodge Corporation. Building permits, Federal Reserve Board. Number of families accommodated in dwellings for which building permits were issued, Bureau of Labor Statistics, Department of Labor. Portland cement shipments, Bureau of Mines. Fabricated structural steel and baths, *Survey of Current Business*.

Has Building Been Overactive?—Has the active construction during recent years been due to filling up the deficiency created during the war and the postwar economic disturbances? Or has there been overbuilding, or building of a premature character, so that the country cannot long proceed with such large programs? The discussion of various types of construction in succeeding pages is designed to throw some light on the answers.

From a national point of view, investment in actual physical capital appears to have been within the savings funds available, and studies by Dr. Willford I. King indicate that construction now represents a smaller part of the national income than during the prewar period. But his studies also indicate that building construction, when considered as depending on the population, and annual increments to it, has been relatively high since 1924.

It is difficult to compare construction volume between periods by physical measures based on the production and use of building materials.

Shifts between hollow tile and brick for certain purposes, plasterboard instead of lath, changes in design such as lower ceiling heights, thinner brick walls, lighter steel and concrete structural members, and more complete equipment, all combine to make a smaller quantity of basic materials go farther, and allowances for salvaged materials are uncertain. But the figures in the following table show that current construction is not wholly out of line with prewar programs:

Per capita production	1913	1921	1926	Per cent change 1926 from 1913
Lumber (board feet).....	395	249	317	- 20
Common and face brick (number).....	92	49	85	- 8
Structural steel (pounds).....	69	27	76	+10
Portland cement (pounds).....	357	342	530	+49

Sources of basic data.—Population estimates of the National Bureau of Economic Research; lumber production figures of the Bureau of the Census, Department of Commerce, and the Forest Service, Department of Agriculture, as published in the *Commerce Yearbook*; common and face brick production figures of the Bureau of the Census and Bureau of Mines, Department of Commerce; structural steel production figures of the American Iron and Steel Institute; Portland cement production figures of the Bureau of Mines, Department of Commerce.

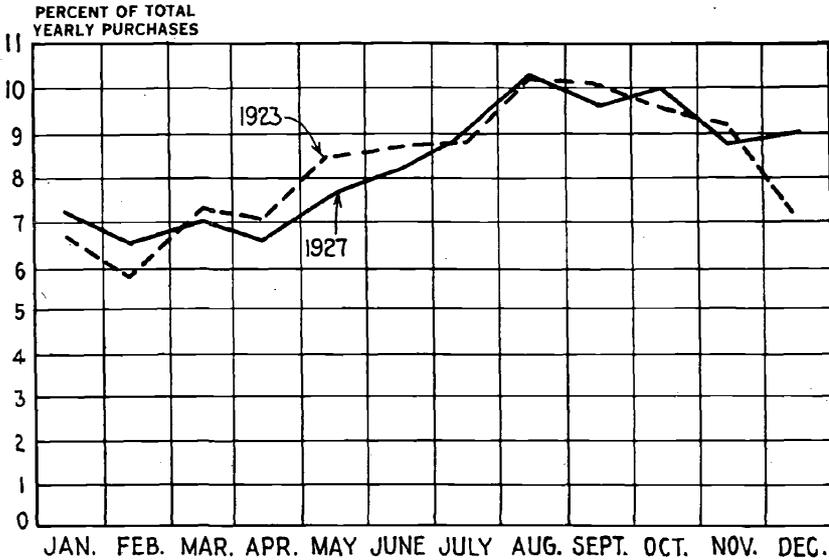
The decrease in per capita production of lumber and brick may have been offset by other factors such as the use of concrete and gypsum products, hollow building tile, and second-hand brick. The increase in cement consumption, which requires a corresponding consumption of sand and gravel, has been due in some measure to the increased use of concrete for building streets and roads. This gain may be considered as partly offset by the considerable decrease in the per capita consumption of steel rails from the years just before 1914.

Planning.—Relatively more construction than formerly is now definitely planned with reference to long-time growth in requirements. Construction by practically all types of public utilities, such as railways, electric light and power, gas, and telephone companies, is largely non-competitive and nonspeculative. This may be contrasted with the highly speculative building of various railways during the last third of the nineteenth century, which so frequently led to receiverships.

Industrial corporations, more easily financed, have been able, for the past five or six years, to plan and finance developments without interference from general financial conditions. It is not so easy to say that long-time trends in demand for residential buildings and some types of commercial buildings are more carefully considered than formerly. There is, however, much more planning of a basic nature than before the war. The number of official city planning commissions has been multiplied several times. At least 206 of the 287 largest cities have such bodies at work on comprehensive plans for their future physical develop-

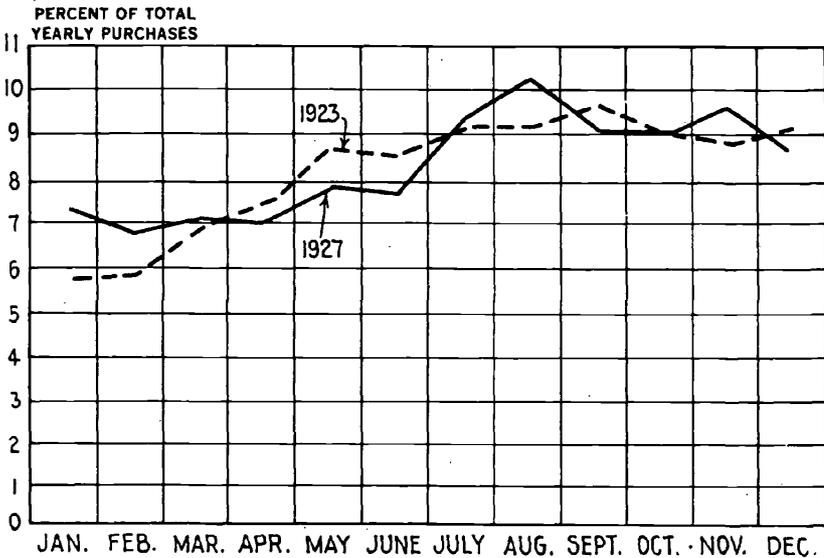
CHART 1.—MONTHLY EMPLOYMENT OF BUILDING LABOR. YEARLY TOTAL = 100

Source: Reports of contractors in 24 cities to Division of Building and Housing, Department of Commerce



MONTHLY PURCHASES OF BUILDING MATERIALS. YEARLY TOTAL = 100

Source: Reports of contractors in 18 cities to Division of Building and Housing, Department of Commerce



ment. Their long-term programs for constructing and financing public works help private owners to gauge the probable direction and character of growth.

Zoning ordinances are now in effect in more than 700 cities and towns, covering about three-fifths of the urban population of the country. Almost all of these have been adopted since the war and are helping to stabilize the character of particular districts and thereby encourage durable construction. Comprehensive city planning frequently leads to remedies for past mistakes, such as tearing down old structures in order to make way for new thoroughfares and the erection of large modern structures. Planning often emphasizes the logical necessity of large highway bridges, the relocation of passenger and freight terminals, and the undertaking of water supply and sewer developments.

Further evidences of broadly planned construction are the development of the national "Federal aid" highway system by the Bureau of Public Roads in co-operation with state highway departments, and the interconnection of electric power systems.

Group Efforts to Secure Stability.—At the same time, intergroup and community efforts to assure seasonal and long-time stabilization in building encourage owners to look ahead and formulate long-term building programs. These local efforts, recommended by the Committee on Seasonal Operation in the Construction Industries, in 1923 and 1924, have had the support of contractors, building material groups, architects, engineers, real estate groups, building-trades labor, financing agencies, and bodies representing owners.

Chart 1 shows for 1923 and 1927 the monthly distribution of labor pay rolls and receipts of materials by representative contractors in about twenty cities. The years 1923 and 1924 showed a distinct improvement in this respect over 1922.

Statistical analyses of present and prospective building activity have enabled building material manufacturers to plan their production and stocks more carefully, with less seasonal fluctuation in the number of workers employed.

II. TECHNICAL AND PRACTICAL TRENDS

No one can deny that there has been a tremendous advance in planning and carrying out road-building projects and other large engineering undertakings. In the case of buildings, particularly small houses, where the greatest criticism has been directed, distinct improvements do not wholly dispel the charge that the building industry has failed to keep pace with other groups in modernizing its methods. But the groundwork laid by the tendencies for construction to follow nation-wide, rather than purely local standards, undoubtedly forms a necessary basis for further advances.

Growth in Professions.—One indication of the increased appreciation and use of engineering data and technical skill is the growth in membership of professional societies, such as the American Society of Civil Engineers, the American Institute of Architects, and the American Society of Heating and Ventilating Engineers, several of which have more than doubled in membership since 1913, and some since 1919. There has also been a notable increase in the technical activities of trade associations in the construction industries, and in national and local co-operation between groups.

More Careful Design.—Structures are commonly planned more carefully for adaptability to use and economy in construction. For large structures the architects often collaborate with committees of experienced building managers. Architectural and engineering firms, assigning more important rôles to cost engineers, consult more often with contractors on economical features of design. Much construction is carried on by public utilities and large corporations, such as chains of stores and motion picture theaters, which employ specialists who work out plans with great refinement. Some of the larger mortgage bond companies also employ architects to pass on the design of structures and to suggest desirable improvements. Improvements in small house design include better lighting, heating, best insulation and ventilating, economy in the use of materials, regard for efficient construction methods, and for durability and appearance of the finished structure.⁴

Results of Competition in Building Materials.—Competition between the producers of various types of building materials has been keen, with many millions of dollars spent for group and association advertising and other forms of promotion, research, and engineering service. Quick-setting cements and mortar materials, wallboards, composition strip shingles, quick-drying lacquer paints, materials for heat insulation and sound deadening, and the evolution of dozens of varieties of floor, wall, and roofing materials illustrate the trends.

National trade associations, with annual budgets for research and promotion work running into the hundreds of thousands of dollars, are active in encouraging the use of Portland cement, lumber, steel, brick, hollow tile, and other materials. Building material retailers more and more have had to carry nationally advertised commodities and brands in order to meet the wishes of customers.

Standards for Materials.—Great savings have been effected in the use of materials through more careful analysis of strains and stresses, wider use of specifications, and better inspection, which permits greater reliance on uniform quality. There is a distinct and steady trend toward thinner masonry walls and lighter structural elements.

⁴ See Housing Standards, Chap. I, Consumption, p. 29; Chap. V, Marketing, p. 324.

The American Society for Testing Materials has adopted many new specifications for building materials.

The transforming of construction from a local to a more nearly national basis has been reflected in and stimulated by the adoption of simplified practice recommendations, which have recognized standard dimensional varieties for about fifty building material items, including yard lumber, common brick, hollow tile, concrete building units, metal lath and builders' hardware.

A standard filing system, established in 1916 by the American Institute of Architects, is finding wider use by manufacturers of materials.

Durability.—Increased durability of structures is emphasized by attention to fire-resistive features and use of noncorrosive metals. The amount of wood treated with preservatives to lengthen its useful life doubled from 1922 to 1927. The subgrading and substructure of highways is more carefully prepared, and the surfacing more lasting.

Better Organization and Reduced Time for Construction.—The execution of many more contracts of large size has been accompanied by improvements in the organization of many contracting firms. The time required for executing practically all types of construction operations has notably diminished; a development stimulated during the war and made possible by better planning and scheduling of work, improvements in design, increased shop fabrication of materials, more dependable delivery of materials, and wider use of labor-saving devices and equipment on the job. Groups of subcontractors have developed highly specialized organizations and their relations with contractors and designers have tended to become closer.

Improved Machinery.—Labor-saving machinery has been made more adaptable and reliable, and is more widely used.⁵ Development of the gas engine has had a widespread influence. Motor trucks have left to horses only a small share of the hauling of materials, and have also cut into the use of light railways for filling operations. Gas engines have made possible a much wider use of compressed air furnished by small portable motor-driven units, and they and electricity are displacing steam in power shovels. The motor truck with its self-dumping body is displacing the wheelbarrow and common labor, in the assembly of materials in the hoppers and skips of concrete mixers and pavers. Standardization of ratings of capacity, and other features of mixers and pavers, has been effected by the co-operation of the manufacturers who in 1923 organized the Mixer Manufacturers, Bureau affiliated with the Associated General Contractors. This now represents nearly 100 per cent of the machine

⁵ See *Mechanization*, Chap. I, Consumption, p. 52; Chap. II, Industry, Part 1, p. 84, Part 2, p. 104; Chap. IV, Transportation, Part 1, p. 262; Part 2, p. 312; Chap. V, Marketing, pp. 324, 328, 350; Chap. VI, Labor, p. 483; Chap. VII, Management, p. 511; Chap. VIII, Agriculture, pp. 551, 557-572.

capacity in both classes of mixers. The greater mobility and capacity of motor trucks have stimulated the use of power shovels on a greater number of jobs and kept larger shovels at work a greater portion of the time.

Many devices have been perfected for cutting down labor at the building site, particularly in the use of concrete and masonry materials, where there are material-handling problems.

Field studies show a more general rental of construction machinery and equipment, even by the large contracting firms. This practice has tended to reduce overhead carrying costs and transportation charges, and has encouraged and made available at less cost the use of the most efficient types of equipment.

Public Regulation.—The modernization of municipal building regulations has been accelerated. The enactment of zoning ordinances in more than 700 municipalities has already been mentioned.

The Department of Commerce Advisory Committee on Building Codes has been at work since 1921 on recommended requirements for municipal codes, co-operating with many other groups. Its findings have been used in code revisions in at least 120 municipalities.

National trade associations have extended their work of securing fair treatment for their materials in building codes. Several new associations have appeared in this field.

The Building Officials' Conference has gained in membership and strength. Corresponding regional bodies have been formed. Altogether, the framing and administration of building codes has come to be more widely recognized as a serious problem, to be solved by scientific research and engineering skill.

III. TRENDS IN VARIOUS TYPES OF CONSTRUCTION

In this section of the chapter, the portion on housing devotes particular emphasis to single-family houses, that on large buildings to office buildings, and that on public works and utilities to road building.

Housing Construction.—The construction of single dwellings and of multifamily apartments represents two distinct developments during the period covered by this survey, both of which are related to other economic and social changes. One- and two-family dwellings (the latter of declining importance in recent years) accommodate more families and are more important from the social point of view, because they house the great bulk of families in which there are children of school age and younger. In relation to the nine-year postwar average, construction of single houses made a quicker start in 1919 than the construction of apartments and held up better in 1920 and 1921. Families who had to find accommodations used their capital and credit to acquire homes, taking the risk of a possible fall in prices, where investors hesitated to erect apartments.

The postwar construction of one-family houses reached a peak nationally in 1925, a year prior to a peak in multifamily structures. One-family dwellings, when not erected by the occupant, are almost always erected for sale rather than for rent. Overbuilding of this type, in advance of immediate demand, has resulted in various cities in violent curtailment of programs, such as a 50 per cent reduction from one year to the next, but growth in demand has usually resulted in a fairly rapid recovery of more normal conditions. Careful surveys of annual vacancy were found by field investigation to stabilize this type of building fairly well in Utica, N. Y., and similar surveys are being undertaken in a growing number of cities. Overbuilding of apartments which are built to rent apparently does not have such an immediate effect upon new construction; even where new apartments are not needed they may be partly occupied, and they may be sold to investors who are not well informed as to local conditions. Where rental surveys have been made, they usually reveal a considerably higher percentage of vacancies in apartments than in houses.

It is not strange, all things considered, that relative to the nine-year local averages residential building was slow from 1919 to 1921 in New York and Chicago, where the building of multifamily structures predominates.

The desire of families to live in more satisfactory homes and surroundings has been the force behind the large home-building program. As has been customary, the new houses erected in and around cities have been for families in the upper income groups, with comparatively little construction for families in the lower groups which, for the most part, occupy older, less desirable structures. Many of the features which make the newer homes more desirable are made evident in succeeding paragraphs dealing with changes in the design, structure, and equipment of houses.

The private automobile and the bus, with improved roads, have greatly enlarged the area within which dwellings may be located, and have permitted comparatively open developments in attractive locations, to an extent that would not have been possible before the war. The demand for outdoor recreation favors the home situated away from the center of the city. The family's enlarged radius of movement due to the automobile, together with the neighborhood movie, the radio, and shorter working hours, strengthens the call toward the suburbs.

In many cities the percentage of vacancies in run-down and undesirable dwellings, particularly in congested districts, has been mounting during recent years. It is reported that the diminished number of new immigrants has much to do with this situation. In a number of cities the construction of shacks or other forms of cheap temporary dwellings, such as occurred soon after the war, has practically ceased.

Although the lowest priced new houses being erected in many cities are out of reach of most families having less than average incomes, they represent improved minimum standards as to light, air, and sanitary facilities. This is likely in future to be reflected in better housing conditions, for the worst accommodations in use to-day are usually structures which, when erected, were far short of meeting the present minimum standards for new dwellings. Owing to the desire of well-to-do families to move into more modern quarters, families less well-to-do may in effect receive a subsidy through their ability to obtain second-hand houses at a discount greater than actual depreciation. A problem may arise as to the use of land now occupied by the poorer types of houses which are now being vacated.

Home Ownership.—Although the percentage of home ownership has declined during each decade for which records are available, the decline from 45.8 to 45.6 per cent from 1910 to 1920 was less than in any preceding decade. A strong counter tendency appeared in many cities, and the percentage of families owning their homes in the 68 largest cities actually increased from 1910 to 1920. Fifty-five of these 68 cities showed an increased proportion of home owners in 1920 compared with 1900, while only 13 showed a decrease. Yet these figures do not take account of the increase in homes owned beyond the territorial limits of cities.

Business men and social investigators almost all agree that the preference or custom of owners to sell rather than to rent, which became strong during the World War and immediately after, has resulted in a much increased percentage of home ownership.

On the other hand, the proportion of families living in apartments has increased owing to the character of postwar construction. Apartments co-operatively owned can hardly be considered important as yet from a statistical point of view. It may be observed, however, that home ownership is of the greatest importance to families in which there are minor children, and that apartments are predominantly occupied by other types.

Construction of Houses.—Much of the attractiveness of new houses is owing to their design and construction. What follows is an account of changes observed during field investigations. These changes also throw light on the intensified competition among different building materials and reveal a tendency to use materials which leave the factory in such shape as to require little labor on the building site.

Design.—There have been changes in fashion in the architecture of houses, with marked improvement in some, particularly those selling above \$10,000 or \$12,000. There are many evidences of improving taste, and efforts on the part of builders to meet it, for the less expensive houses.

There has been a large increase in the circulation of architectural papers and of periodicals devoted to home building, home furnishing,

home equipment, and landscaping. One such periodical established in 1922 has approximately 900,000 circulation. Publication of house plans in women's magazines has been stimulated by newspaper syndicates, two of which furnish material for home-building pages with circulations of several million a week. The Architects' Small House Service Bureau, formed in 1920 through the American Institute of Architects, has done much to encourage the appreciation and use of good designs for small houses, and numerous building material groups have issued plan books of improved quality. The garage usually receives attention in new subdivisions and in laying out the lots. It may accommodate two cars, and in more expensive dwellings it is often built-in, or attached to the house. The house itself is smaller, except for the living room, and may even omit the dining room; but it is vastly better equipped and usually better built. Hardwood floors in living quarters, linoleum in the kitchen, built-in bathtubs, and tile floors in bathrooms illustrate developments which, among other advantages, make housekeeping easier.

Lumber is still the basic material for dwelling construction since it is prevalently used for interior framework, floors, stairways, and exterior and interior trim, even in houses whose walls are built of other materials. At some points, however, there have been inroads upon lumber by other building materials.

Intense competition is evident in roofing materials where composition strip shingles, which require but little labor for erection, compete with wood and other types. Copper, zinc, asbestos, slate, burnt clay, and cement tile all find some use on sloping roofs; while roll and built-up composition materials compete with types of sheet metal for flat or low-pitched surfaces. Copper and copper bearing steel vie with plain galvanized steel sheets for gutters and downspouts.

The walls and interior partitions of houses represent another field of rivalry. Under the weather surface, composition boards made from sugar cane refuse, or wood pulp and gypsum, compete with wood sheathing, and any of these may compete with common brick or hollow tile as a backing behind an outer course of brick. For interior wall surfacing, wood and metal lath with two or three coats of plaster have to compete with plasterboards to which one or two coats of plaster are applied. Some of the newer materials do not cost less in total, although they reduce costs on the job.

Perhaps the greatest and most marked improvement is in plumbing, with a tendency even in the moderately priced house to increase the number of fixtures and bathrooms. Lavatories are often installed on the first floor and in the basement. The grade and quality of the fixtures have improved as in the case of the built-in tub which formerly was installed only in the rich man's house but is now found extensively in houses selling for \$8,000 and even less. The old-style tub on legs is

difficult to find except in the cheapest new houses. Chromium plating is used on plumbing fittings. Colored and acid-resisting plumbing fixtures and colored tile have been introduced and are finding their way down from the more expensive to the cheaper houses. Weather stripping and materials for heat insulation make houses cooler in summer and help to reduce fuel expenditure in the winter.

Built-in ironing boards, increased use of kitchen cabinets, and the electric refrigerator are types of aids for the housewife. Entrance doorways, doorframes, and other millwork are available in somewhat improved stock designs. Electrical installations include more base and wall plugs, and heavier wiring to accommodate the use of electrical appliances.

Although it cannot be said that the building of houses is appreciably less of an individual undertaking than before the war, or that the building of houses on a large scale has made a positive contribution to improved technique, the national advertising and distribution of building materials have had a pronounced influence. Co-operative research and promotion, carried on by trade associations and large individual manufacturers, have contributed to the evolution of new materials and of better adapted uses for old materials. Economical production has been made possible in a number of instances by large-scale manufacture.

Two-family Houses.—Construction of two-family houses, which occupy a position between single houses and multifamily apartments, reached a peak in 1923 and 1924, when in 257 cities they accommodated about one-fifth of the families provided for by all new construction. Since that time they have steadily diminished in importance, being less than one-seventh in 1927.

Apartment Houses.—More than one-half of the apartment houses erected during the postwar period are in the New York and Chicago metropolitan districts. In general they have been built mainly to meet the needs of families without children of school age. They fit in with the economic independence of single women, and with the increased ease of keeping house for small family groups. The restaurant and tea-room, the delicatessen, organized facilities for social recreation, the motion picture, the submergence of the boarding house, and the relief of apartment dwellers from the personal responsibility for maintenance, care of grounds, and looking after the furnace, all tend to offset the advantages of living in larger housekeeping units in detached houses. Furthermore, apartments which house more people in a limited space provide more convenient locations.

Of the housing accommodations outside of New York and Chicago which were provided by new construction in 1926 and 1927, probably less than 30 per cent were in multifamily structures. This percentage is considerably smaller than the percentage of families having no children,

or having only one child of school age or younger. The garden apartment specially designed for families with children, and situated on low-priced land with ample space around it, has not been tried out extensively.

The newer construction usually obtains proportionately higher rentals on account of its freshness, improved equipment, and arrangement of space. Ceiling heights are lower, on the whole, and mechanical refrigeration is much advertised.

Nonresidential Buildings.—Commercial structures, including offices, banks, stores, warehouses, and garages, form the largest single group of nonresidential buildings. Of these, offices (the most important subgroup), which are built mainly for rent, have shown the greatest fluctuations from one year to another. The floor space represented in contracts for new industrial buildings, which consist mainly of manufacturing plants and are next in importance to commercial buildings, was more than twice as great in 1919 and 1920 as in any two of the seven succeeding years. Such contracts showed a marked recession in 1924 as compared with 1923, and in 1927 as compared with 1926.

“Social and recreational” and “religious and memorial” buildings have shown a fairly consistent and generally upward trend since 1919. Educational buildings, hospitals and institutions, and public buildings taken together have shown reasonable stability since 1922.

Large Buildings.—Large buildings have been the most distinctive feature of postwar nonresidential construction. Although many had been built before the World War, they have since assumed great importance. Office buildings, department stores, hotels, apartment houses, and schools have tended toward larger units.

Large buildings permit a better utilization of land area, and in general are more carefully planned than small ones. It has paid to work out design with refinement of detail, in order to secure economical construction and to make structures convenient, comfortable, and attractive to tenants. Building of large structures has helped stimulate research into the properties and uses of materials. It has developed more contracting firms with better organizations; it has improved and made more widespread the use of construction equipment and machinery on the job. Erection of large buildings has called for the solution of complex engineering problems, and has thus kept pace with the growth of technical societies. It has also called for the services of many highly skilled building craftsmen.

Office Buildings.—The erection of large office buildings has been one of the striking developments in this field and emphasizes the significance of the greater size of structures. They make a certain appeal to pride; the organization which owns one gains prestige and advertising; the tenant likes to be known as occupying a large well-known building; and citizens feel that large buildings are a symbol of progress. On the other

hand, high buildings have brought recognition of the dangers of congestion which follow intensive development of land without allowing enough open space for traffic, light, and air. These dangers have been recognized in hundreds of communities in the height or bulk restrictions of zoning ordinances. Some recognize that a high building may not be objectionable from a community point of view, if it has enough space about it so that it does not shut off too much light and air from neighboring property, and if street and other transportation facilities are adequate. The setbacks required above a certain height by the zoning ordinances of New York and other cities have resulted in a new type of architecture, often used even where not required. Zoning ordinances often put a premium on buildings covering a large area which can take the best advantage of setbacks and other provisions for light and air.

Capital required for large offices comes sometimes from local banks and corporations, and sometimes from individual investors. National sources of investment funds are also drawn upon, particularly for first mortgage money. Insurance companies have found mortgage loans desirable, and mortgage bonds based on such security have been made popular by investment banking concerns and mortgage bond houses.

Although office buildings are usually undertaken after a thorough analysis of probable demand, there have been complaints that many have been constructed because a promoter, a contractor, and a mortgage bond company want business and put up structures for which there is too little demand. Occasionally promoters have financed practically the whole cost of the undertaking through securities sold to the public before construction was commenced. In some such cases, they have realized handsome profits; in others, investors have suffered loss. Such abuses involve two related dangers—loss to investors, and the danger of overbuilding.

The annual retirement of a certain portion of the principal of each issue of mortgage bonds is customary and affords some protection to security holders. In general, the total losses to security holders have not been alarming. It is not yet possible to give a ready answer as to the extent of overbuilding of office structures which may have taken place in various cities. Reports of the National Association of Building Owners and Managers indicate vacancies of over 15 per cent as not uncommon.

On the whole, the newer structures appeal to tenants on account of modernized features and convenient location. They are usually better designed from the point of view of modern office methods, have modern high-speed elevators, and are better equipped for the comfort and convenience of tenants. As in the case of houses, vacancies in new structures are of greater significance to the building industry than those in obsolete buildings.

Methods and Materials of Construction.—There has been a widespread application of good methods of construction. Better management in the case of large building is reflected in the decreased time required; perhaps 30 or 40 per cent less than before the war.

Reinforced concrete, something of a curiosity for an office building in 1910, has become common and competes with steel for structures 12, 15, and even more, stories in height. Reinforced concrete structures are more often economically designed, partly because increased knowledge of the properties of concrete and better control of the proportions of mixtures permit greater reliance on the strength of the finished concrete. The "tin-pan" or "dome" method of constructing concrete floors saves much material, and its use has been promoted by standardization of sizes of the metal forms. Removable and adjustable shores and other labor-saving devices for installing and removing wood and metal forms have been improved and can be leased from specialized concerns.

For steel frame construction, the allowance of a basic working stress of 18,000 pounds per square inch instead of 16,000 pounds—which had been standard in building codes for about thirty years—now permits, in many cities, a saving of approximately 11 per cent in the amount of steel required for a given structure. This change was recommended by a committee of consulting engineers employed by the American Institute of Steel Construction, which was formed in 1922, and by the Advisory Committee on Building Codes of the Department of Commerce.

There is more building of steel frame and reinforced concrete buildings during the winter months, with swinging scaffolds and tarpaulins protecting masonry workers as the walls are filled in.

The devices for anchoring brick and stone work have been improved. Partitions made with quick-setting mortars, or with steel framework, covered with composition boards which take the place of sound-deadening felt and lath, and are finished with quick-setting plaster, are aids to rapid work.

Although contractors report that the value of equipment required for a job has not greatly increased, there is some use of paint spraying machines and wider use of power saws, floor scrapers, and electrical drilling and cutting apparatus of other types. One contractor reports that satisfactory portable air compressors have trebled the use of pneumatic tools during the nine-year period.

The material storage bins used on large jobs have been given up in many cases⁶ because of the more general establishment of well-equipped sand and gravel producing plants, and the longer hauls which can be economically undertaken by modern dump trucks, with dependable, accurately timed deliveries on the job.

⁶ See *Size of Inventory*, Chap. II, Industry, Part 1, p. 91; Chap. IV, Transportation, Part 1, pp. 267, 292, 302; Chap. V, Marketing, pp. 332, 344, 350; Chap. VII, Management, pp. 508-509.

Architects, engineers, and builders, interviewed during the course of this study, agreed that the spread between building-trades wage rates and material prices which has taken place since 1913, and even since 1923, has not meant a corresponding increase in the ratio of labor to material costs in the construction of large buildings. Several well-qualified men believe that the ratio has not gone up perceptibly. The reasons assigned are the use of labor-saving equipment, less loss of time on account of poor management, occasional use of laborers for unskilled work formerly performed by more highly paid craftsmen, the tendency to finish materials more completely before they arrive at the site, and the use of more expensive materials at some points. It requires no more work, for example, to install brass pipe than the less expensive steel.

Miscellaneous Commercial, Recreational, and Industrial Buildings.—The construction of cold-storage warehouse buildings has been an important item in the commercial building field. The chain store, a common feature of neighborhood shopping centers, often occupies a structure planned by a large centralized organization. The construction of automobile service stations has been promoted by competition among the large oil refining companies. Automobile sales rooms, accessories stores, repair garages, storage garages, and radio sales shops, all serve to illustrate the demand for new commercial buildings which may be created by new or rapidly expanding industries.

The enormous growth of the motion picture industry has involved a corresponding demand for theaters. A striking feature in this connection has been the consolidation of local theaters into nation-wide chains, with the application of more careful analysis to the planning and design of new structures of this type. Great advances have been made in planning the acoustics of auditoriums.

Increased leisure and income have also resulted in greater construction of athletic fields, stadiums, gymnasiums, swimming pools, and golf courses.

The total construction of industrial buildings is still liable to considerable fluctuation from year to year, but since 1922 there have been no such wide swings as during the three preceding years. Considerable changes from one year to another still occur occasionally in single industries. In 1927, for example, the F. W. Dodge Corporation reported that new building contracts for the petroleum, lumber, and leather industries represented in each case less than half, in point of value of floor space, the respective amounts in 1926. Such changes appear to result from the free exercise of judgment of the business executives as to the best time at which to build, with less dependence than before the war upon current rates of interest, on temporary conditions in the money market, and on group psychology.

There is, of course, more general reliance upon electric power received from central stations, and less upon individual factory power plants, a fact making for stability in the construction of generating facilities. Building structures represent, on the whole, a decreasing proportion of the total investments in industrial plants, with machinery and equipment representing a growing proportion. Improvements in manufacturing processes in some instances diminished the amount of space required. Dependable railway transportation has reduced in many cases the amount of space required for storage of raw materials. Investments in equipment and storage facilities which permit the economical handling of materials appear to have been large.

Postwar industrial construction has been characterized by improved standards for lighting, ventilation, flooring, and working conditions generally.

The decreased time required for construction, without excessive payment for speed, has been of great importance in industrial buildings. Certain types are well enough standardized for design and construction to proceed expeditiously. One firm of engineers reports constructing in 280 calendar days a plant including 20 buildings, most of them 4 stories high and of reinforced concrete, at a total cost of about \$7,500,000. One of these buildings of reinforced concrete, 800 feet long, 90 feet wide, and 4 stories high, was completed and turned over to the owners ready for installation of machinery in 44 calendar days.

Public Works and Utilities.—The construction programs of public works and public utilities during the postwar period have been notable not only for their actual and relative magnitude, but for the developments in planning, financing, and technique.

There has been little of the spectacular reaching out into undeveloped territories which characterized the decades of railway building during the last part of the nineteenth century, but rather the filling in and extension of facilities for transport and communication within areas already inhabited and beyond the pioneering stage.

From the point of view of business stability, the changed character of construction of this type is important because it is planned pre-eminently with a view to meet needs which exist or are readily predicted. The most striking developments in this field, namely, highways and electric power generation and transmission, have been conditioned on technical improvements, rising living standards, and large savings funds available for capital investment.

General Trends in Public Works.—Among the outstanding developments in the construction of public works during the postwar period may be mentioned more careful and comprehensive long-time planning based on surveys of needs, sounder financing, improvement in design

TABLE 6.—PUBLIC WORKS CONSTRUCTION OF SIX TYPES
(In thousands of dollars)

Class	1913	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
Total.....	192,893	398,152	406,729	459,042	521,079	630,424	685,673	719,212	811,741	932,703	1,049,353
Waterworks.....	20,778	19,762	22,141	38,330	36,221	62,698	61,445	69,368	61,647	53,189	99,437
Sewers.....	27,269	38,506	37,418	38,805	43,584	66,905	74,553	84,577	103,741	118,032	100,669
Bridges.....	22,629	27,144	33,801	29,730	43,477	66,985	68,564	69,876	83,383	143,645	129,078
Streets and roads.....	58,407	225,655	262,641	313,303	334,694	361,837	415,216	421,039	484,898	525,069	612,610
Excavation, drainage, and irrigation....	22,059	14,710	14,166	10,270	19,551	24,059	27,010	40,080	27,810	42,005	37,660
Federal Government.....	41,751	72,375	36,562	28,804	43,552	47,940	38,885	34,272	50,262	50,763	69,881

NOTE.—Minimum cost of projects listed in this table are as follows: waterworks, excavation, drainage and irrigation, \$15,000; other public work, \$25,000; Federal Government, \$150,000.

Source: *Engineering News-Record*.

from a professional and technical point of view, and better machinery and equipment.

Authorities issuing municipal bonds have demonstrated that they take advantage collectively of temporary fluctuations in the investment securities market which enable them to obtain low rates of interest on their offerings. This fact may be significant in connection with the movement to stabilize general business conditions by the timing of public works.

Road Building.—*Planning and Finance.*—Not long before the World War the United States was considered backward in respect to its improved highways. The few well-surfaced highways had been planned and constructed by counties and even smaller governmental units, mainly with reference to local needs, without much effort at co-ordination and often with none too good construction or maintenance. The development of one of the finest systems of improved roads in the world has been effected mainly since the World War and has paralleled the increase in number of automobiles. More than a billion dollars annually is now spent for the construction and maintenance of rural roads, and another \$400,000,000 or more by cities for street improvement and maintenance. From 1890 to the outbreak of the World War there was a gradual awakening to the need for improved roads, and some states established highway departments during that period. In 1916, the passage of the Federal Aid Highway Act required all the remaining states to create highway departments in order to take advantage of its provisions. The Federal Bureau of Public Roads, in co-operation with the state authorities, worked out a well co-ordinated network of 185,772 miles of principal roads throughout the country, of which about one-third has been improved.

There remains much room for better planning of highway improvements, for in many states there is too little co-operation between the authorities in adjoining counties, and between the authorities of cities and those of neighboring rural territory. In some cases the state highway authorities are able directly or indirectly to secure reasonable co-ordination. Ten or twelve regional planning bodies, all created since 1922, are doing excellent work. Sound financing of outlays for highways has been encouraged by the highway departments of a number of states, and also by the investment bankers in their individual capacities and through their association.

Administration.—There has been a striking improvement in the administration of road building and maintenance. State highway departments have come more often to recognize the advantages of letting contracts at times which permit a maximum working season. They have learned to let out the work in units of suitable size for a season's work by a road building outfit. Co-operation with organizations repre-

senting road builders has resulted in improved documentation, including not only contract forms but questionnaires to establish the competence and responsibility of bidders. A number of state highway departments now centralize the purchase of cement and other road building materials and provide for their use by contractors.

Types and Specifications of Roads.—More careful study of the need for rural roads has resulted in a careful planning of types of surfacing and subsurfacing for the amount and character of traffic. There has been a great improvement in the grading and maintenance of the earth, gravel, and sand-clay roads, and there is a much better understanding of methods or proportioning such surface materials. Water-bound macadam and sheet asphalt surfacing are yielding to other types. The total mileage of concrete roads was increased from 7,000 at the end of 1918 to 50,000 at the end of 1927. Several state highway departments maintain research departments and, with a number of trade associations and professional societies, they have co-operated with the Bureau of Public Roads in its research program and in the co-ordinating activities of the National Board for Highway Research. One result of research has been an almost universal change, effected since 1921, from the practice of having concrete surfacing of uniform thickness, or thicker at the center, to the present practice of having it thicker at the edges. A number of state highway departments in co-operation with state universities conduct annual road schools for the personnel of the state, county, and township highway departments. On the whole, inspectors now are carefully trained. Good maintenance standards for local roads are often encouraged by the conditions under which state aid is granted.

Construction Methods and Equipment.—Although no new methods for cutting and filling and preparation of the subgrade have been developed within the past ten years, there have been constant improvements in the machines used for such purposes—improvements comparable in some ways to those in passenger automobiles, representing greater reliability of performance, ease of handling, and accuracy, and increasing the amount of work which may be accomplished.

The *Engineering News-Record* gives a number of concrete instances which illustrate recent developments in the equipment used for road building and other engineering projects:

The usual power shovel in 1920—then it was invariably a steam shovel—had a boom and a dipper stick, but little else that we recognize on the modern machines. There were few crawler units, and those that did appear were of fragile construction. There were no alloy-steel dippers, no unit-cast steel frames, no cut gears running in oil. A choice of power plant, to all practical purposes, did not exist. Now, electric motors and steam, gasoline, or Diesel engines may be had. And a power shovel is no longer just a shovel. By removing a few bolts and re-reeving the lines, it becomes a crane or a dragline. In the old text books and magazines we look in vain for the finished mechanism that is the modern road paver. The tractor of 1920 was more

often than not a miniature threshing engine, from which the modern tractor differs so radically that it can hardly be said to be an adaptation from these earlier models. This development has taken place in less than a decade—in construction terms, during the handling of three or four large jobs.

There has been much advance in the methods of handling and storing materials. Contractors have the choice of light railways and of motor trucks for hauling materials. The materials are frequently placed in storage and are loaded into trucks or cars by gravity. On concrete road-building operations the truck bodies are frequently divided into compartments into which a proper mix of sand and crushed stone is placed. Sacks of cement are emptied over the aggregates, often while the truck is turning, before it dumps the successive batches into the skip of the paver. The paver has a swinging horizontal boom to convey each batch as it is mixed to the proper point for dumping. Compared with prewar methods, when the hopper of the concrete mixer was filled from wheelbarrows, the changes are no less than revolutionary.

A typical gang for constructing a concrete road, consisting, under methods in use before 1919, of about 74 men, would construct up to 350 feet of pavement per day; in 1928 a gang of 45 men would often construct 800 feet of pavement per day. Accepting these estimates, which have been judged reasonable by several competent engineers, the daily output per man increased from 4.7 to 17.7 lineal feet of road surfacing. Accompanying the changes in methods, contractors have had to increase the amount of equipment required for road building, and its value now commonly amounts to from 35 to 50 per cent of the value of the season's contract. Some of this equipment is purchased on the installment plan and some of it is rented, although many contractors purchase their equipment outright. Reports by the Bureau of Public Roads indicate that the increase in road-building activity since 1919 has not resulted in the employment of appreciably more men.

Vehicular Bridges and Tunnels.—Accompanying the great increase in road building, there has been—particularly during the past three or four years—a great expansion in the building of large vehicular bridges and tunnels at strategic points. Many of these have been constructed as toll bridges by private companies and by public authorities, and are thus expected not to become a direct burden upon taxpayers. All of these bridges occasion construction of other types, including highway approaches; and those in or near cities usually result in many new buildings erected to take advantage of increased site values.

Airports.—The development of airports, including the grading and drainage of sites, surfacing of runways, lighting, and construction of hangars and accessory buildings, represents virtually a new type of construction which has been undertaken recently in hundreds of American communities.

Miscellaneous Public Works.—The percentage of the population furnished with running water has continued to increase, and cities have had to carry out large engineering projects in order to take care of increasing demands for water. Improvements in methods of treating sanitary water supplies have resulted in the reconstruction of many local plants for treatment of water. These tendencies seem likely to continue. The satisfactory treatment and disposal of sewage is assuming considerably more importance as cities grow larger and the problem of stream pollution becomes more serious and more generally recognized. Adequate disposal of sewage has been regarded as a luxury rather than a necessity by a considerable proportion of the public and their representatives—at least when it comes to an outlay of money for such purposes—but the general tendency is toward enlarged expenditures for sewers and sewage disposal plants.

The construction of fire-engine houses and police stations and other public buildings has shown a comparatively steady growth, although this is not an important branch of construction. There seems to be some tendency to place less reliance on liberal use of space as a means of lending a distinctive character to public buildings and more reliance on excellence of artistic design and improved setting.

Educational Buildings.—The enormous school building programs of the postwar period have been brought to the forefront by the increasing proportion of young people attending high school and college, and by the consolidation of rural schools. The students come to school by automobile or bus, a development closely connected with the increase of automobiles and improved highways. Many school buildings are now expected to be of a monumental type and to have fairly elaborate special facilities for laboratory and manual training work and gymnasiums, swimming pools, and other features for physical training and recreation. It appears to be the prevailing view among boards of education that they have hardly been able to take care of the great increase in school enrollment, and that there are still in many cities large numbers of schools which do not meet present-day standards for lighting, ventilation, equipment, or play space. There has been an undeniable improvement in the design of school buildings and many architectural firms have gone carefully into the matter and have handled school buildings as a specialty. Careful surveys of the community's needs are usually made before going ahead. There appears to be general knowledge on the part of responsible local authorities of developments elsewhere throughout the country, and this in turn leads to a general demand for the best that can be obtained. The value placed upon education, which is evidenced by the increased number of families whose children go to school, and the excellent market for tax-exempt securities with which to finance school construction, appear to have contributed

toward the large programs. There has been little public opposition to expenditures made for school buildings.

Hospitals and Institutions.—The increased construction of hospitals and other institutions has resulted apparently from a wide realization of the value of specialized plant and equipment for handling patients. This has been occasioned partly by the advance in elaborate facilities for diagnosis and treatment of disease, such as the X-ray, bacteriological laboratories, pulmotors, and hydrotherapy. At the same time, the smaller living quarters occupied by many families have increased the difficulties of caring for disabled persons in the home. Hospitals have characteristically received splendid support from private contributions, and the general prosperity during recent years has resulted in increased private as well as public donations for the erection of such buildings.

Public Utilities.—The enormous development of the electric power industry, both in generating stations and transmission and distribution lines, is an outstanding feature of the last decade, the fundamental causes of which include the discovery and application of more economical methods of long-distance transmission of power, distributing of loads by means of interconnection of stations, and a great reduction in cost of generating power through improvements in design. These developments are described in the chapter on industry.

From the point of view of construction, this development, involving the investment in new plant and equipment of more than \$750,000,000 annually in the past three years, is important because it has been undertaken by companies of strong financial backing, most of them having a virtual monopoly of service within defined geographical areas, and having good reasons to avoid premature investments or duplication of facilities. Approval of projects by public service commissions serves as an independent check.

Gas companies, electric railways, and the telephone and telegraph companies have had like reasons for carefully planned expansion in line with growing demands from consumers.

The railways, under supervision of the Interstate Commerce Commission, and with the object of effecting economies in operation and providing facilities for growing traffic, have been making their investments in improvements of existing lines, including some construction of new terminals.

The public utility companies, with their skilled engineering departments, have taken a leading part in developing the use of labor-saving equipment. The motor trucks equipped with post-hole augers and derricks for placing telephone and telegraph poles are now familiar sights. The railways, telephone, and telegraph companies are the principal users of preservative-treated wood products.

Railways have been investing large sums in motor cars to carry gangs of men and loads of materials to their work. Another type of motor car with a gas-electric power plant develops electric current to operate electric tools, such as grinding wheels, portable rail saws, track bonding drills, electrical tie-tampers, flood lighting systems, portable saws, and electric driven air compressors. Ballast-cleaning machinery saves a considerable amount of labor. Joints and bolts are oiled by spraying machines, and weeds are destroyed by large burning machines. Air and electric tamping machines and ditching machines also reduce the cost of building, improving, and maintaining railway roadbeds.

Public utility companies operating in cities are large users of trenching machines and of various types of air tools in connection with cutting pavements, and laying and maintaining conduits and pipe lines.

From an economic point of view, the construction of highways and of the types of public utilities just mentioned may be compared with the construction of railways in the United States during the latter part of the nineteenth century, when there were extensions of lines into undeveloped territory, involving large speculative risks whose outcome was dependent upon uncertain factors as to the amount of traffic which might develop, and the time at which it might develop. Furthermore, at that time there was some competitive building of parallel routes not required to handle existing traffic. The public utility field now seems vastly more stable, from the point of view of new construction, than was the case a generation ago, or even just before the war.

IV. LABOR

There has been some tendency in the past decade toward reducing the number of hours in the working week, although 44 hours was common at the beginning of 1919. There has been some local lessening of longer weekly working periods, and within the past two years several crafts in a number of cities have gone on a five-day week of 40 hours. The president of the painters' union reported that 45,000, or one-third of its members, were working the five-day week at the end of November, 1927. The general tendency of building-trades wage scales has been upward since 1921, but too great reliance cannot be placed on these, as in some cases the wage rate may be only nominal and may be below or above the level of wages actually paid.

There has been no very marked trend, either away from or toward trade agreements which restrict employment on building operations to qualified members of trade unions.

The building trades since 1921 have been unusually free from labor controversies. Part of the comparative freedom from strikes has been gained through the operation of the National Board for Jurisdictional Awards in the Building Industry, representing employers, architects,

engineers, and building-trades labor and formed in 1919. Although the labor representatives were withdrawn late in 1927, no important jurisdictional strikes have been reported since.

The advance in this direction virtually eliminated one of the most serious hindrances to stabilized building. A dispute as to which of two classes of subcontractors and mechanics should perform a certain class of work frequently tied up many entire projects involving thousands of other crafts not directly concerned, with great expense to owners, contractors, and the community as a whole.

Recruitment of skilled building-trades labor by immigration has notably diminished, and the industry has been faced with the problem of training competent mechanics. This problem has been met partly by infiltration of workers who have commenced work as journeymen on rougher types of work and gradually acquired experience and skill without formal apprenticeship or instruction. Efforts to encourage apprenticeship in certain crafts in the building trades have been made in a number of cities and have had the co-operation of the Federal Board for Vocational Education. The experience gained and the accumulation of a certain amount of teaching material are perhaps the most significant results of these experiments to date. Establishment of a national school promoted by the Associated Tile Manufacturers has afforded an outstanding example of what well-organized effort can accomplish.

V. GROUP, INTERGROUP, AND COMMUNITY EFFORTS

Group, intergroup, and community efforts to solve problems within the construction industries and in their relations to the public have distinguished the postwar period.

The American Construction Council, formed in 1922, represents the leading groups connected with construction. It includes architects; engineers; general contractors; subcontractors; construction labor; manufacturers of material and equipment; dealers in material and equipment; financial; surety, bonding, real estate, accounting, insurance, and building and loan organizations; chambers of commerce and boards of trade; public utility construction departments; representatives of Federal, state, county, and municipal bureaus or departments concerned with construction; and national associations of builders' exchanges and of building-trades employers' associations and similar associations or federations of building interests.

In several cities, building congresses, all formed since the war, bring together similar groups, including building-trades labor. Several have been particularly concerned with seasonal stabilization, and some have done much to encourage craftsmanship by awarding to mechanics medals and certificates of craftsmanship.

There have been, as already mentioned, successful efforts to promote seasonal stabilization of building activity, city and regional planning,

improved documentation, modernized building codes, more careful selection and economical use of building materials in design, better workmanship, and elaborate research into such matters as the capacity of heating apparatus for buildings of various types. As the membership of trade associations and technical societies has increased, results scientifically established have come quickly and widely into use. Development of simplified practice recommendations and standard specifications has brought many groups together.

As such efforts have become common, the different groups within the construction industries have become mobilized and have come more and more under the public eye. At the same time, there is less indication of collusive control of prices locally—one of the great banes of the construction industry at various times in the past.

The common use of nationally advertised commodities has helped to make it harder for prices to be raised by local collusion, and the intensified competition between materials has had something of the same influence.

VI. SUMMARY

A sustained high rate of construction activity has distinguished the period since 1922 and has contributed to steadiness in many other nationwide industries, such as railway transportation and the production of building materials. This stability in total volume of construction has been achieved in spite of ups and downs in individual cities and regions, shifts among various classes of construction, such as residential and public works, and building costs which have been higher than the general price level when compared with prewar conditions.

Construction has become more national as to standards, and more independent of local financial conditions. More of it is well planned not only from the point of view of architecture and engineering, but with reference to location and probable demand. The various groups which make up the industry are better co-ordinated among themselves and more co-operative with other groups.

Both in design of structures and in construction methods, there has grown up a more general reliance on trained engineers, quicker application of the results of a more intensified research, and closer contact between manufacturers of building materials, designers, constructors, and owners of structures. In the field of building materials, dimensional varieties, specifications, and nomenclature have been more generally standardized, and trade associations and technical institutions have carried on more research on properties and uses. National advertising has served to intensify competition. Economies through improved design and use of labor-saving equipment have been most notable in the case of roads and some other types of engineering construction where large quantities of materials are handled; these economies have been somewhat less con-

spicuous in the case of large buildings, and still less in the case of small houses. There have been, however, notable advances in the design of buildings, both as to architectural quality, arrangement of space, and economical use of materials. Buildings are more completely and elaborately equipped, and more durable and permanent. Trade associations, professional groups, and research institutions have contributed much toward technical advances, and the movement for modernizing building codes in keeping with new developments has made distinct progress. The process of manufacture of building materials is being carried further along in the plant, so that there is less work to perform at the site. The time required for most types of construction has become much less—a tendency greatly stimulated during the war.

Recent national construction programs amounting to more than \$7,000,000,000 annually are conservative in relation to national income and savings, if compared with prewar conditions.

Relatively more construction than formerly is now definitely planned with reference to long-time conditions. The large programs of public utilities, for example, have been carefully designed to provide economical service for the growing needs of the territories covered. Railway building during the last third of the nineteenth century, on the contrary, often was highly speculative, or involved duplication of facilities. City planning and zoning, and analyses by individual owners, have made possible better location of buildings and public works with relation to one another. Conscious efforts to prosecute new work with reference to available supplies of labor and materials have helped to reduce the intensity of seasonal and other temporary fluctuations.

The more even growth of population in recent years, owing to operation of the immigration acts, and the unusual decline in farm population, have affected the demand for urban housing.

The extension of residential areas in and about cities, made possible by the automobile and improved streets, and encouraged by the demand for outdoor recreation, has resulted in a remarkable suburban growth of detached houses. Construction of apartments, usually for adults, has increased.

Minimum standards of light, air, and sanitary facilities in new construction, and growing vacancies in districts where housing is the poorest, indicate improvement in housing standards.

There has been a marked lessening of labor disputes. The five-day week has been sought in various cities by various trades, and is now being tried out under agreements affecting many thousands of workers.

Group, intergroup, and community efforts to solve such problems as seasonal stabilization, improved documentation, better architectural design, standardization, simplification, and credit relations, have gained in scope and intensity during the period studied.