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CHAPTER VI

CONSTRUCTION
(Group IV)

GENERAL CHARACTERISTICS

Group IV covers industries in which the seasonal factors act most strongly not upon the supply of raw materials, nor upon the demand for the finished product, but directly upon the productive activity itself. Most of the industries comprising this group either carry on out-of-door activity or utilize natural elements whose availability changes with the season (inland water transportation). The most important division in this group is the construction industry and this is taken as an example for detailed analysis in this chapter.

a. *Causes of Seasonality in Construction*

The construction industry, defined most broadly, includes not only work on new and old buildings but also the construction of railways, roads, canals, sewers, subways, etc., all engineering projects that have for their final product a durable commodity or a system of commodities attached to a definite location. This great complex of industries, of fundamental importance in the economic structure of the country, has a more conspicuous seasonal problem, perhaps, than any other industry. Carried on mainly out-of-doors and dealing with materials affected by weather conditions, the process of construction is impeded by rains and low temperatures. The ground to be prepared for building is made harder by cold; the cement mixture used as adhesive for bricks can set well only in moderate temperature.

Recent technical progress has succeeded in overcoming many of these difficulties in respect of major types of buildings, such as large office buildings, industrial plants and large apartment houses, which require a year or more for completion.[1] Construction of smaller buildings still remains highly seasonal, however, and the laying of roads or highways in rigorous weather is well nigh impossible.[2]

Added to the purely climatic factor is the influence of customs established in the industry.

. . . . Some of the customs . . . . are: (1) inertia and habit in commencing building operations during the spring months; (2) common rental or leasing dates; (3) wage agreements procedure; (4) habits of doing repair work during the spring or fall; (5) the custom of encouraging more work through the character of advertising at the busiest seasons; (6) spring painting.

Other factors that affect the time of year at which building operations are undertaken are numerous, as the following examples show. There is building for seasonal needs, as in the case of schools, houses in summer resorts and winter resorts, construction of recreation facilities, farm buildings, and elevators for storage of crops, etc. The situation of farmers who wish to be assured of a good cash return from their crops before commencing construction is also to be allowed for. The commencement of buildings in autumn to be completed in the spring is sometimes discouraged by financial institutions when it appears that the period of construction is to be prolonged. Uncertainty in regard to wage scales and material prices also encourages scheduling of buildings for completion in the short-

[1] "During the war and immediately afterward many builders were compelled to carry on a large proportion of their work during the winter months in order to complete their projects within the time set by their contracts. They soon discovered that the cold weather, in itself, presented no physical obstacles which could not be overcome by means of more diligent supervision and a certain amount of protection of the work against snow and ice. Additional experimentation soon convinced them that even the operations which are most adversely affected by freezing temperatures, namely, the pouring of concrete and the masonry work on the exterior or the shell of the building, can easily be safeguarded by the simple device of heating the water and the aggregates in the process of mixing the concrete and by protecting the newly concreted section of the structure by means of canvas inclosures and artificial heat supplied by coke or oil-burning salamanders." Causes of Seasonal Fluctuations in the Construction Industry, *Monthly Labor Review,* September 1931, p. 7. For a good discussion of the possibility of winter construction see also *Seasonal Operation in the Construction Industries,* Report and Recommendations of a Committee of the President's Conference on Unemployment (New York 1924).

[2] "Highway work is unavoidably much more seasonal than building and certain other types of construction. Its great surface area and the impossibility of complete drainage make it impossible fully to overcome climatic effects or, except in minor degree, to protect the work from them as can be done when operations are concentrated in a small area. The work is almost entirely in a shallow surface stratum and is, therefore, affected to the maximum degree by wet and frost. Power machinery depends primarily on mobility for its effectiveness in this field, and mobility both of such equipment and of transportation units is seriously impaired by snow and mud." *Seasonal Operation in the Construction Industries,* pp. 150-51.

est possible time, which, as has before been shown, is a contributing factor in drawing additional workers into the building trades and consequently in accentuating unemployment during dull months.

There are also to be considered the lack of good management methods and the use of antiquated equipment, which prevent the carrying on of work at times when it would be practical if better methods were used. Finally, in the case of public works there is to be considered the legislative and administrative calendar of the federal, state, and local governments and the lack of discretion allowed administrative officers in scheduling the dates of commencement and completion of work under their jurisdiction.[3]

The measurement of seasonal variations in the industry and in the manufacture of related products becomes, then, of especial interest.

b. *Summary of Conclusions*

The detailed statistical analysis, whose main results are presented on Charts 26 through 33 and in Tables IX and X, indicates clearly the seasonal variablity of construction as well as the marked differences in amplitude among the various types of buildings and other construction projects. The swing ranges from relative mildness in commercial buildings to great width in public works and utilities and in the construction of roads.

If marked seasonality characterizes the process of construction as a whole, there are undoubtedly still greater seasonal variations in the consumption of separate construction materials, since each is consumed in a limited phase of the construction process. The task of supplying materials for such variable consumption falls not so much upon the contractors themselves as upon the dealers. While statistical data for purchases and sales by dealers are lacking (except for lumber in some districts), other information clearly shows that dealers bear a heavy burden in the task of filling the variable needs of contractors, as is vividly illustrated by the following quotation:

> The average contractor rarely carries a stock of materials in advance of current needs. His capital is usually limited; he has no suitable storage space even for non-perishable materials; and certain supplies vary so widely in size and shape that it would be impracticable to carry them in any event. So it becomes the dealer's function to provide materials as they are needed, either by filling his yards in advance of the busy season or by calling on the manufacturer when general activity increases in the spring.

[3] *Ibid.*, pp. 106-7.

The extent to which many progressive dealers equip themselves for efficient service is not fully appreciated. The larger yards are planned with great care and ample storage space is provided. Labor-saving devices of many kinds are in use. Cranes for handling steel and brick, continuous belt conveyors and bucket loaders for aggregates, and heavy-duty motor trucks are utilized. All such equipment is expensive. If it is kept operating, it minimizes handling costs and gets materials to the consumer when the latter's calls are most insistent. If it remains comparatively idle during some months, the heavy investment which it represents brings in no returns and the dealer suffers. . . . .

In the dull season so few sales of building materials are made that some dealers operate at an actual loss. Others are content to break even. The office organization must be held together and salaries paid; taxes and maintenance expenses go on; yard workers are let go; and the expensive mechanical equipment already referred to remains unproductive while the interest on the investment in it continues. Some dealers in the smaller cities meet the situation by handling coal and wood.

As the building season comes on and reaches its peak, stocks become depleted, manufacturers' deliveries are slowed up, transportation facilities become congested, and an actual shortage of supplies often occurs. As a result the dealer is unable to make prompt deliveries, and owners or contractors are obliged to wait while their expenses continue.[4]

But, as is shown by the marked seasonal swings that characterize shipments of construction materials by producers, dealers pass on a substantial part of the task of meeting variable demand to the manufacturers. The swings, while of lower amplitude than those in the consumption of the materials in actual construction, are still rather high. This is especially true of Portland cement and of some commodities that are made up in heavy units and are sent out directly to consumers for prompt installation (boilers and radiators). On the other hand, shipments of such materials as lumber show much lower seasonal amplitude than that which characterizes utilization in construction.

Differences among construction materials in seasonal variability of shipments seem to depend upon three factors: (1) the proportion in which the material is used for various types of construction, subject to seasonal disturbances of varying amplitude and pattern; (2) the proportion in which the material is consumed in new units, replacements, or uses other than construction; and the similarity or lack of similarity in the seasonal patterns of these diverse channels of consumption; (3) the number of intermediaries between the manufacturer and the final consumer. Where one or more links inter-

[4] *Seasonal Operation in the Construction Industries*, pp. 47, 49-50.

vene, these links, whether they be wholesalers or retailers or both, assume some of the burden of meeting the variable demand for construction materials and thus relieve the manufacturer by allowing him to ship at a much more even rate than he would were he to supply the final consumer directly.

Where shipments by manufacturers remain subject to marked seasonal disturbances, some part is passed back to the productive process. Generally, however, production of construction materials proceeds at a more even rate than shipments. Exceptions are observed in cases where definite seasonal factors influence production directly, as for example, in common brick and in some of the less important lumber species, such as western pine and California white pine.

Differences in seasonal variability of output of the several construction materials, in so far as they are not due to the disparate influence of climatic conditions on the output or to differences in the variability of shipments, arise from technical factors in the productive process. In some branches, as in boilers and radiators, it is profitable to produce for stock, maintaining productive activity at an even pace throughout the year. In others technical conditions of production make possible changes in volume at not too great expense (cement, asphalt). Output is then varied to meet, at least in part, fluctuations in demand and to prevent accumulation of excessive seasonal stocks.

Throughout, stocks serve in their usual capacity as buffers between production and shipments, between shipments and the needs of final consumers. Because of comparative lack of data on stocks held by links other than manufacturers, the analysis cannot be complete. As far as the data go, they show that the volume of stocks depends upon technical conditions of finishing the commodity for final use, and the differences in service rendered by intermediaries in supplying the variable needs of final consumers.

DETAILED COMMENTS

A. The Construction Industry

1. Permits and Contracts Awarded

By the very nature of the operations involved construction is scattered throughout the country and the statistical problem of measuring its volume adequately is not an easy one.

Continuous quantitative measurement is obtained only indirectly, in the series on building permits and on contracts awarded.

Building-permit figures represent the valuations placed upon construction jobs when permits are granted (or in a few cases when plans are filed) by the building departments of our towns and cities. They therefore include small structures as well as large and alterations as well as new construction. On the other hand, they do not cover construction carried on outside of city limits, and in some cities also, public works of certain types are not included because permits are not customarily required for such operations. The claim is made that the permit records are compiled by officials only as an incident to their administration of city building codes and that therefore the figures may represent either undervaluations or overvaluations. It is true that in the smaller cities and towns, the jobs are generally undervalued, but such tendencies are likely to persist and do not affect seriously the importance of the permit index as an indicator of changing trends in the building industry though they impair its value as a measure of construction volume.[5]

An investigation by the United States Bureau of Labor Statistics of the records of 19,310 buildings in ten cities for 1929 revealed that of the permits issued only one per cent was allowed to lapse. This small number constituted only 2.2 per cent of the estimated cost of all the buildings. Excavation was begun from six to thirteen days after the permit was issued; the interval was shortest for small dwellings and longest for public buildings. The average number of days which elapsed between starting excavation and completing a building ranged from ninety-eight for one-family frame dwellings to one hundred ninety-eight for public buildings. Of course, the larger buildings took more time than is represented by the averages for their group, as is indicated by the length of the construction interval when buildings are classified according to their estimated cost.[6]

Thus there is an interim of from three and a half to seven months between the issuance of the building permit and the completion of the structure. Since permits during recent years were at seasonal peak in March, actual ' production ' of buildings must have been at seasonal peak between July and No-

[5] W. C. Clark, The Construction Industry, p. 185, in *Representative Industries in the United States,* H. T. Warshow, ed. (New York 1928).

[6] See Elapsed Time in Building Construction, *Monthly Labor Review,* November 1931, pp. 15-24.

vember, a timing due partly to an attempt to complete buildings before the October leasing date but still more to the desire to avoid any burdens of construction during the cold months, December to February.

Contract figures are collected by field agents of a competent private statistical organization and are supposed to represent the contract price of construction actually started or definitely ready to start. When general contracts are not let, presumably estimates of cost are used. They do include large projects carried on outside the limits of cities and all public works, but they fail to cover most low-cost new buildings, practically all alteration work and construction in rural districts. . . . . contracts awarded perhaps represent for the area covered a more accurate total of construction volume already started or about to start. Permits issued, representing as they usually do an earlier stage in the construction process, are probably a slightly more sensitive barometer of changes in the trend of building activity.[7]

Total building contracts awarded show a seasonal pattern somewhat similar to that of permits. The peak occurs later, however, in either April or May, and the high levels last longer, extending through most of the summer. This difference may arise from the anticipatory character of permits and the awarding of contracts even after the actual launching of construction operations.

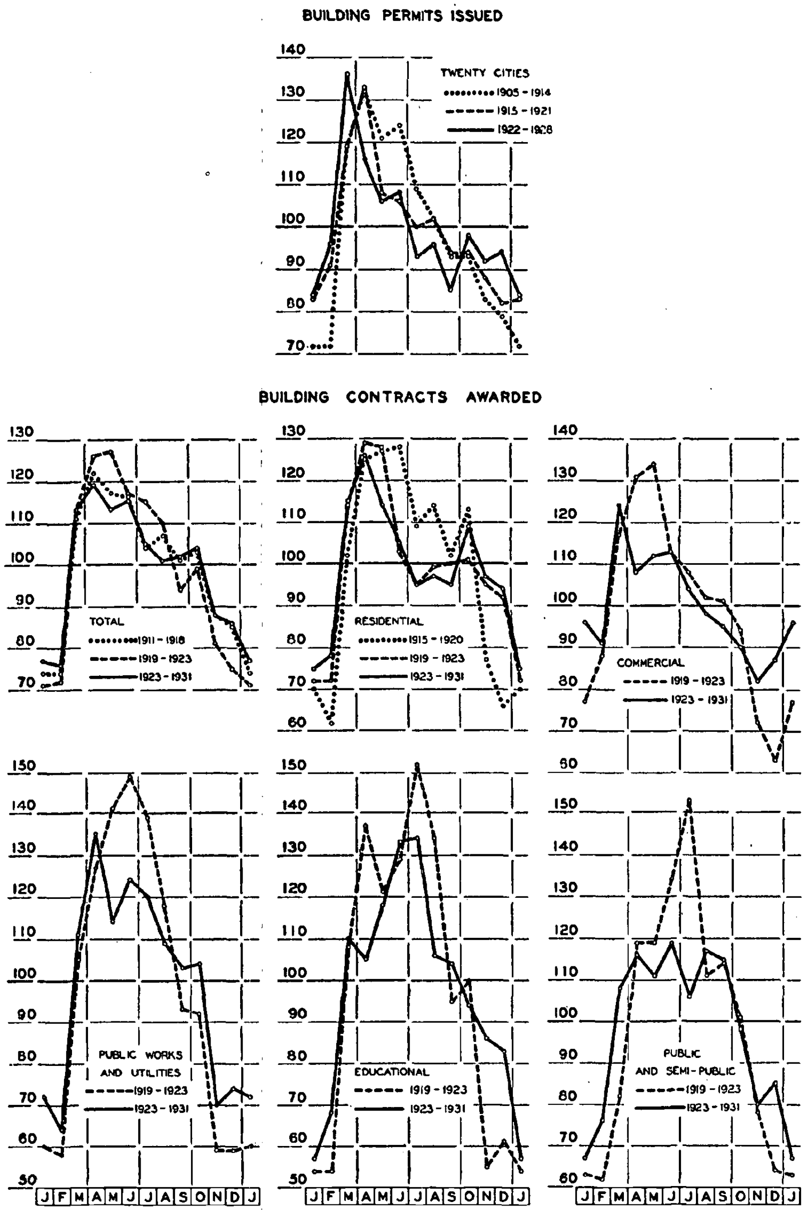
The various groups of building contracts show marked differences in the persistence of seasonal pattern. For industrial buildings no reliable seasonal pattern could be established. And, as Chart 26 shows, the stability of pattern is more marked in such groups as educational buildings and public works and utilities than in commercial or residential buildings (although in the latter the agreement of pattern is quite close for the last two periods).

Still more conspicuous are differences in amplitude. In buildings devoted to business use the seasonal swing is mildest. Thus, in industrial buildings no persistent seasonal variation could be found, and in commercial buildings the average deviation of the index during recent years is the smallest of all. Residential buildings have a somewhat higher seasonal amplitude. The two groups, " educational " and " public and semi-public," still cover buildings primarily; the former include schools, the latter, hospitals, churches, social and recreational, public and other institutional buildings. In both groups the swing is appreciable, owing largely to the seasonal character

[7] Clark, in *Representative Industries in the United States,* pp. 185-6.

CHART 26

SEASONAL MOVEMENT IN BUILDING PERMITS AND CONTRACTS



of the use of the structures, especially schools and some of the social and recreational buildings; and in the case of public buildings, the amplitude may be intensified by the formalities of the legislative and administrative calendar. But the most

TABLE IX

AMPLITUDE OF SEASONAL VARIATIONS: CONSTRUCTION ACTIVITY

Series	Average Deviation	Range
Building Permits Issued, 20 Cities, 1905-14	17.9	60
1915-21	11.3	51
1922-28	10.7	52
Building Contracts Awarded		
Total, 1911-18	13.3	48
1919-23	18.0	56
1923-31	12.1	43
Residential, 1915-20	20.4	66
1919-23	12.5	57
1923-31	11.5	51
Commercial, 1919-23	17.7	71
1923-31	10.2	42
Educational, 1919-23	30.2	98
1923-31	18.5	77
Public and Semi-Public, 1919-23	25.2	91
1923-31	15.5	52
Public Works and Utilities, 1919-23	29.8	91
1923-31	20.0	71
Federal Aid Highways		
Miles Completed, 1922-31		
Relative Deviations	36.2	122
Absolute Deviations	33.2	107
Miles Under Construction, 1922-31	4.8	15
Miles Initiated, Derived, 1922-31	39.0	126
Concrete Pavements, New Orders, 1923-31	32.9	107
Index of Construction Volume, 1924-31	20.7	62

marked seasonal swing characterizes contracts in the group of public works and utilities, largely because they cover such engineering projects as water-front developments, highways, bridges and lighting systems. Most of these projects are more susceptible than buildings to interference by inclement weather.

2. Construction of Roads

'Federal Aid' highways are improved roads built by states with federal aid, and in 1925 constituted about 45 per cent of total mileage built by states. Total mileage of these Federal Aid highways under construction shows a persistent but mild seasonal pattern (Chart 27). Its mildness is due to the fact that the index is a very large cumulative total of mileage begun.

The seasonal movements in mileage under construction, with peak months from July to October inclusive, seem to suggest a lag behind the construction indexes discussed above. The cumulative character of the series accounts for such timing, since if construction begins on a high level in early summer, it continues at high levels all summer. The cumulative total of such a seasonal will have a peak at the end of the summer and a trough *following* the low winter months, that is, in February or March.

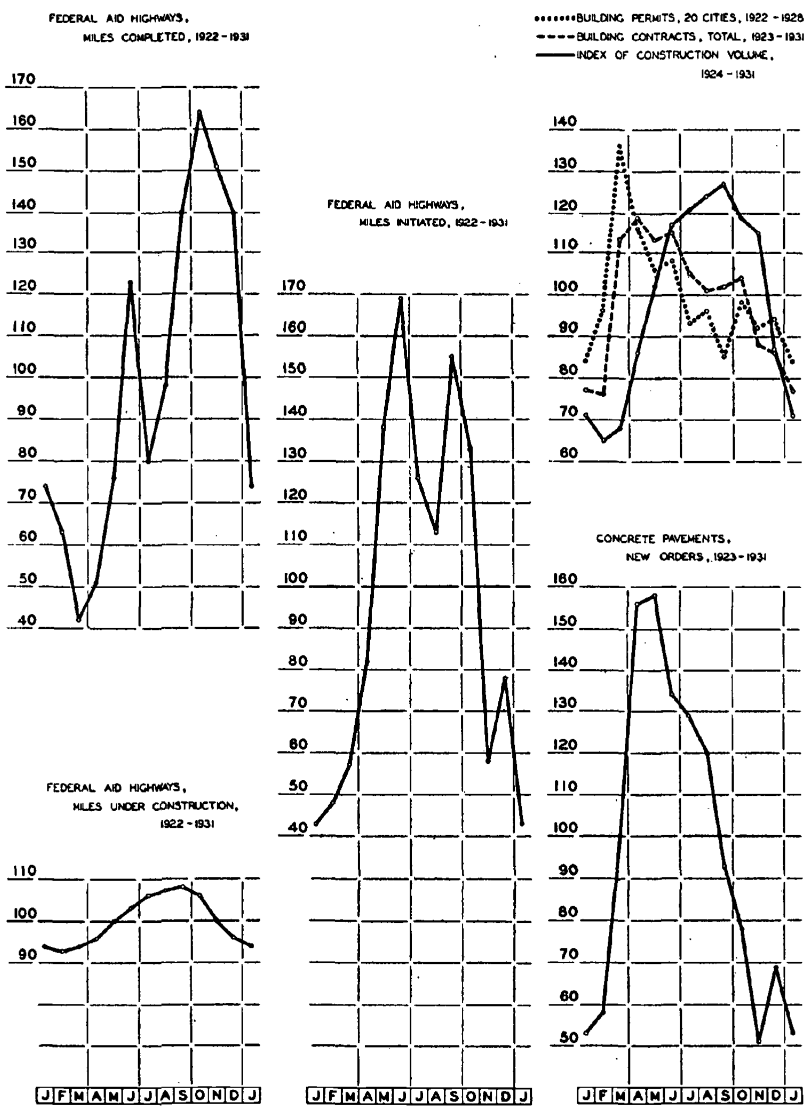
The index for mileage completed bears out these suggestions. Because of its small absolute size, two seasonal indexes were computed for this series: one, by averaging absolute deviations from a twelve-month moving average; the other, by averaging relative deviations. The seasonal swing, computed either way, is much wider than that for mileage under construction. This large difference can be explained by the fact that during the period covered total mileage under construction is 15.4 times that completed in an average month.

The difference between the seasonal pattern in mileage completed and any of those described earlier in this chapter is striking. There is a minor peak in June but the index rises (with a break in July) to a major peak in October, dropping to a trough in March. The late peak in mileage completed is within the time range indicated for the completion of buildings, the peak in which, as was noted above, lies between July and November.

From the indexes for roads completed and roads under construction it is possible to derive a seasonal index for mileage of roads initiated, upon the obvious assumption that, on the average, the number of miles initiated is equal to the number of miles completed. Such a derived index, presented in Chart 27, shows that: (1) Seasonal variations in the number of miles initiated are wide. (2) The direction of movement

CHART 27

SEASONAL MOVEMENT IN GENERAL CONSTRUCTION, HIGHWAYS AND PAVEMENTS



corresponds to that of the patterns encountered heretofore. The major peak is in June, the secondary peak in September. The very low months are November to February inclusive. (3) There is an interesting relation between the two peaks in miles begun and miles completed. The major peak in miles initiated (June) may be related to the major peak in completion (October). This indicates an average time span of construction of either four or sixteen months. If the minor peak in miles initiated (September) be associated with the minor peak of completion (June), then the period of construction is either nine or twenty-one months. Judging by ratio of miles under construction to miles completed, we may suggest that roads begun in early summer are likely to be finished at the end of the building period of the next year, that is, in October, while roads begun at the end of summer may have to wait two winters for completion early in the second summer after they were begun.

A partial substantiation of the derived index for mileage of highways initiated is found in the seasonal index for new orders for concrete pavements which cover primarily roads, from 60 to 70 per cent of total area; the remainder cover streets and alleys. The peak in new orders is in May, a month prior to the peak in mileage initiated, and there is similarity even in the small peak in December. The amplitude of new orders is also large, although somewhat below that in miles of highway initiated.

3. Total Construction

The index of construction activity, compiled by the Associated General Contractors of America, purports to represent actual installations, in contrast to contracts let. The index is a simple average of structural steel bookings, common brick bookings, Portland cement shipments, loadings of sand, gravel and stone, shipments of face brick and of enameled sanitary ware. To allow for lag between the factory and the construction job, the index computed from these data for a particular month is given as the construction index for the following month.

On Chart 27 the seasonal swing for this index of construction volume is plotted, together with the seasonal indexes for the two other important construction indicators: building permits and contracts awarded. The chart presents an interesting sequence of peaks and troughs. The peak in permits is in March, in contracts in April, in the volume of activity in September. There is a somewhat less regular sequence of troughs. In permits two troughs occur: one in September, the other in January; both contracts and volume of activity are lowest in February. Seasonal movements seem to be smallest in permits, about the same in contracts and much wider in the volume of activity. The validity of this last showing may be doubted, since the construction index is a simple arithmetic mean of the various series of shipments. In such an average the most variable indexes are likely to receive the heaviest weight.

B. Construction Materials

1. Portland Cement

The consumption of Portland cement for various uses in 1926 was estimated to be as follows: [8]

Use	Percentage
Public and Commercial Buildings	26.0
Houses (exclusive of rural)	8.5
Paving and Highways	27.5
Sidewalks and Private Driveways (exclusive of rural)	5.5
Small Town and Farm Uses	18.0
Railways	5.5
All other	9.0

Thus about one-third is utilized in paving, highways and sidewalks, another third in buildings, and about one-fifth for small town and farm purposes. We might expect then to find rather large seasonal variations in the consumption of cement and in all the series which describe activity directed toward providing the supply.

Shipments of Portland cement do show marked seasonal swings, with a peak in August and high levels from May through October (Chart 28). These fluctuations are passed on to cement production. Weather affects cement output also directly, and not only through its influence on the rate of construction, but it is the indirect influence that is obviously greater.

[8] Estimate by the engineers of the Portland Cement Association, reprinted in *Mineral Resources of the United States, 1926,* II, 319, from *Concrete,* May 1926.

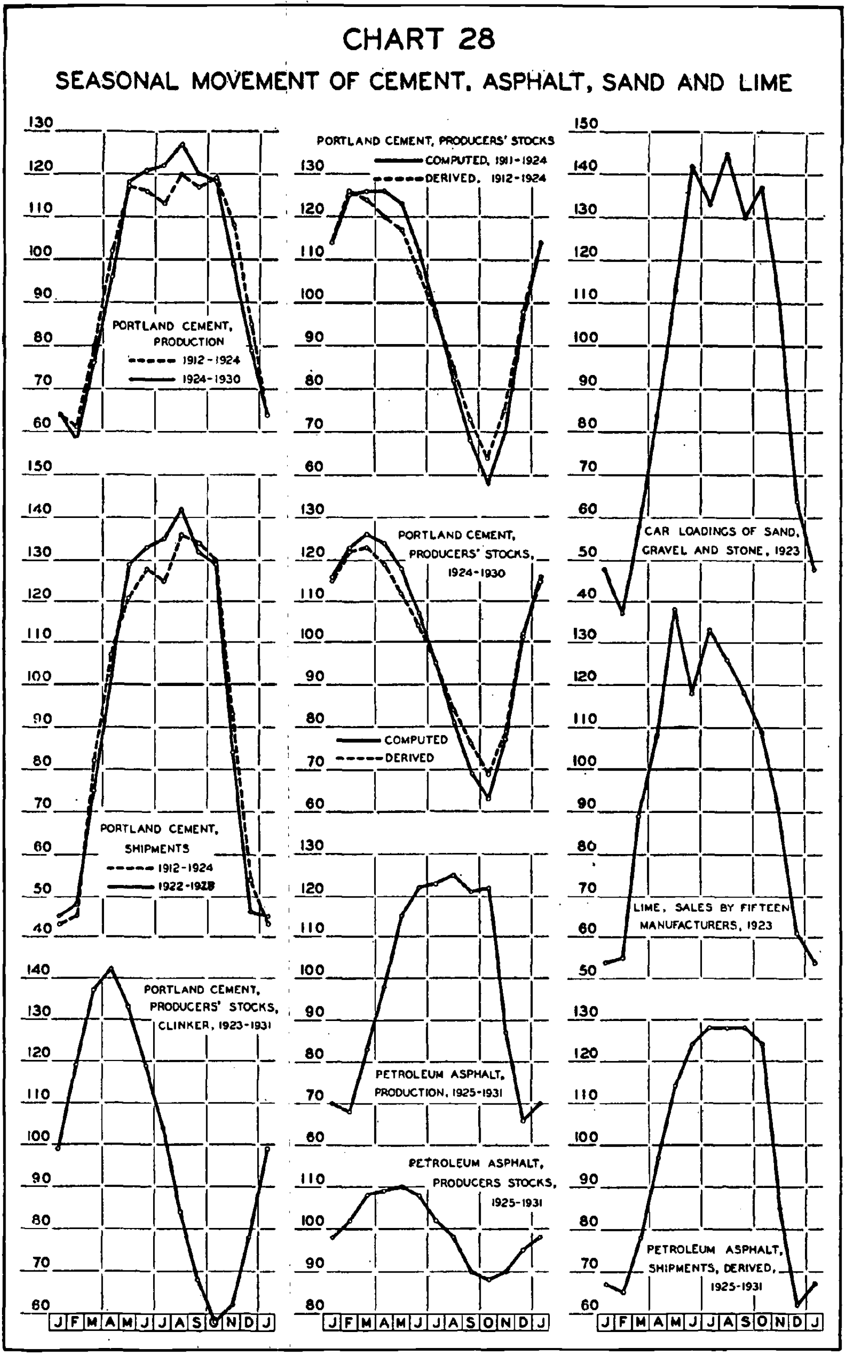


CHART 28
SEASONAL MOVEMENT OF CEMENT, ASPHALT, SAND AND LIME
PORTLAND CEMENT, PRODUCTION
1912-1924
1924-1930
PORTLAND CEMENT, PRODUCERS' STOCKS
COMPUTED, 1911-1924
DERIVED, 1912-1924
CAR LOADINGS OF SAND, GRAVEL AND STONE, 1923
PORTLAND CEMENT, SHIPMENTS
1912-1924
1922-1928
PORTLAND CEMENT, PRODUCERS' STOCKS, 1924-1930
COMPUTED
DERIVED
LIME, SALES BY FIFTEEN MANUFACTURERS, 1923
PORTLAND CEMENT, PRODUCERS' STOCKS, CLINKER, 1923-1931
PETROLEUM ASPHALT, PRODUCTION, 1925-1931
PETROLEUM ASPHALT, PRODUCERS STOCKS, 1925-1931
PETROLEUM ASPHALT, SHIPMENTS, DERIVED, 1925-1931
J F M A M J J A S O N D J

TABLE X

AMPLITUDE OF SEASONAL VARIATIONS: CONSTRUCTION MATERIALS

Series	Average Deviation	Range
CEMENT AND ASPHALT		
Portland Cement		
Production, 1912-24	18.5	59
1924-30	21.2	69
Shipments, 1912-24	30.3	93
1922-28	33.7	97
Producers' Stocks		
Computed, 1911-24	21.2	68
1924-30	19.2	63
Derived, 1912-24	18.0	62
1924-30	16.2	54
Producers' Stocks, Clinker, 1923-31	25.4	84
Asphalt (Petroleum)		
Production, 1925-31	21.3	59
Producers' Stocks, 1925-31	6.7	22
Shipments, Derived, 1925-31	24.3	66
BRICK AND TILE		
Common Brick		
Shipments, 1924-31	14.7	53
Unfilled Orders, 1921-31	9.8	39
New Orders, Derived, 1924-31	19.4	89
Producers' Stocks, 1921-31		
Burned	13.5	46
Unburned	16.6	57
Production, Derived, 1924-31	27.2	94
Face Brick		
Production, 1923-31	12.2	50
Shipments, 1923-31	23.7	86
Producers' Stocks, 1923-31		
Computed	7.7	24
Derived	7.5	24
Unfilled Orders, 1923-31	12.9	47
New Orders, Derived, 1923-31	22.9	83
Floor and Wall Tile		
Production, 1924-31	5.2	22
Shipments, 1924-31	9.7	35
Producers' Stocks, 1924-31		
Computed	3.4	13
Derived	2.8	10

TABLE X (CONTINUED)

Series	Average Deviation	Range
LUMBER		
Lumber, Total Cut, F. R. B. Index, 1919	7.3	28
1925–27	4.3	16–17
1929	4.7	16
Southern Yellow Pine		
Cut, 1917-23	4.5	21
1923-31	3.5	15
Shipments, 1922-31	5.6	23
New Orders, 1922-31	4.9	20
Mill Stocks, 1922-29		
Computed	1.2	5
Derived	0.9	4
Western Pine		
Cut, 1917-24	29.5	91
1924-31	21.6	74
Shipments, 1921-31	10.4	35
Mill Stocks, 1922-31		
Computed	3.2	11
Derived	3.5	11
Lumber Sales by Retail Yards		
Minneapolis, F. R. D., 1920-31	35.5	110
Chicago, F. R. D., 1926-31	19.1	68
Kansas City, F. R. D., 1926-31	11.4	48
Lumber Stocks at Retailers		
Minneapolis, F. R. D., 1922-31	5.7	21
Chicago, F. R. D., Derived, 1927-31	2.8	8
Kansas City, F. R. D., 1926-31	2.2	8
Lumber Sales at Wholesale		
Minneapolis, F. R. D., Derived, 1922-31	19.3	78
Chicago, F. R. D., 1927-31	12.5	41
Kansas City, F. R. D., Derived, 1926-31	10.1	42
Maple Flooring		
Production, 1923-31	4.8	15
Shipments, 1924-31	12.6	51
Producers' Stocks, 1923-31		
Computed	6.4	20
Derived	9.4	29
New Orders, 1923-31	6.8	38

TABLE X (CONTINUED)

Series	Average Deviation	Range
STEEL ROOFING AND PAINT		
Fabricated Structural Steel		
Shipments, 1924-31	7.3	28
New Orders, 1922-28	5.3	26
Dry Roofing Felt		
Production, 1923-31	11.6	40
Producers' Stocks, 1924-31	6.2	26
Shipments, Derived, 1924-31	12.1	42
Prepared Roofing, Shipments, 1920-23	13.9	52
1928-31	20.8	68
Paint, Varnish and Lacquer Products, Sales, 1928-31		
Industrial	10.7	40
Trade	18.5	85
Total	14.8	61
RADIATORS AND BOILERS		
Radiators		
Production, 1925-31	9.0	39
Shipments, 1925-31	28.3	104
Producers' Stocks		
Computed, 1926-31	12.9	41
Derived, 1925-31	12.6	41
New Orders, 1926-31	27.4	95
Cast Iron Boilers		
Production, 1925-31		
Square	10.2	60
Round	11.2	63
Shipments, 1925-31		
Square	33.8	129
Round	26.8	114
Square Boilers, Producers' Stocks		
Computed, 1926-31	10.8	37
Derived, 1925-31	10.5	34
Round Boilers, Producers' Stocks		
Computed, 1926-31	8.8	28
Derived, 1925-31	8.6	29

TABLE X (CONTINUED)

Series	Average Deviation	Range
SANITARY WARES		
Shipments		
Baths, 1917-24	9.4	34
1924-30	13.5	47
Lavatories, 1919-24	5.8	24
1924-30	10.6	42
Sinks, 1919-24	6.6	25
1924-30	10.5	36
Producers' Stocks		
Baths, 1919-24	22.4	78
1924-30	9.5	32
Lavatories, 1919-24	9.2	33
1924-30	5.2	20
Sinks, 1919-24	10.8	37
1924-30	7.5	27
Production, Derived		
Baths, 1919-24	6.1	24
1924-30	7.8	33
Lavatories, 1919-24	6.2	37
1924-30	7.2	32
Sinks, 1919-24	6.3	34
1924-30	8.0	42
New Orders		
Baths, 1918	41.9	158
1924	7.0	31
1930	25.5	80
Lavatories, 1918-30	7.2	32
Sinks, 1918	26.9	95
1924	7.1	31
1930	19.2	63

Large as the seasonal swings in cement production are, they are of appreciably lower amplitude than those in shipments. The disparity is taken care of by seasonal variations in stocks held by producers. These seasonal variations can be freely interpreted as a cumulated discrepancy between the seasonality of production and shipments, as is shown by the graphical comparison on Chart 28 of the computed and derived indexes for stocks. The similarity of the two is close for each of the periods covered.

In connection with the changes in seasonal amplitude from period to period, an interesting question arises. Seasonal variations in both production and shipments were wider during 1924-30 than during 1912-24. Stocks, on the contrary, had a narrower amplitude of seasonal variations between 1924 and 1930 than from 1911 to 1924. How is it possible that stocks which serve to supply large seasonal demand in months when production cannot cope with it should show a narrower seasonal swing in the period when shipments show a wider seasonal swing?

Two explanations are possible: first, although both production and shipments increase in seasonal amplitude, the absolute discrepancy between them may diminish. This does not appear to be true, however, for if we summate the production-shipments discrepancies without regard to sign, we obtain 162 for the period 1912-24, and 158 for the period 1924-30, an insignificant difference. The second explanation, more plausible in the present instance, is the relative increase in the stocks retained by manufacturers, reflected in the change in the stocks-shipments ratio from 1.29 for the period 1912-24 to 1.49 for 1924-30. Arithmetically, this tends to reduce the discrepancy between production and shipments when translated into an index of stocks. Economically, it means that the relative seasonal variation in stocks necessary to meet the fluctuations in shipments can be smaller.

2. Petroleum Asphalt

Asphalt, like Portland cement, is used in the construction of both roads and buildings. There are two varieties produced, 'petroleum asphalt' and 'native asphalt and related bitumens', but the former is of so much more importance than the latter that attention can be directed to it alone.

In 1929 about 1.7 million short tons of petroleum asphalt, or over 40 per cent of total output, went into paving in the form of either asphalt or flux; about 1.5 million tons, or slightly less than 40 per cent went into roofing and waterproofing.[9] Data on petroleum asphalt, therefore, reflect activity in what is almost exclusively a construction raw material.

A question arises in connection with the conspicuous seasonality of petroleum asphalt output which is clearly shown

[9] *Mineral Resources of the United States, 1929,* II, 532-3.

in Chart 28. It was pointed out in Chapter V that the refining of petroleum, that is, the production of gasoline, shows a very mild seasonal. How can a mild seasonal characterize the output of the main product and a very marked seasonal that of the by-product?

The answer seems to be that after the gasoline and other light fractions of petroleum have been distilled off, it is at the discretion of the producer to determine the relative proportion of asphalt and fuel oil that shall be made from the crude. Hence, during the summer months, when the demand for asphalt is above the average, a larger proportion of asphalt and a smaller proportion of fuel oil is made, while during the winter months the proportions are reversed.[10]

In view of this control by producers over the amount of asphalt to be turned out, it is not surprising to find that producers' stocks are on the average very small and that the seasonal swing characterizing them is quite mild. The average ratio of stocks to production during recent years was 0.8, that is, the refineries did not keep stock in excess of a month's output. Whatever stocks are kept are adjusted in preparation for demand. They are high in spring, just preceding the summer and autumn demand, and very low from September to January.

From the indexes for stocks and production a derived seasonal index for asphalt shipments can be computed (Chart 28). The seasonal patterns in shipments and in production are quite similar, except that shipments remain on a high level from July through September instead of reaching a peak in July, as does production. But shipments, like production, are high from May to October and low from December to March inclusive. It is significant that shipments of asphalt show more of a seasonal swing than does production. This difference between the two indexes may be accepted as indicative of their actual relation, despite the fact that the index for shipments is derived. The numerous applications of the checking scheme have proved the method of derivation to be quite reliable, especially for conspicuous seasonal variations.

[10] See Asphalt and Related Bitumens, by A. H. Redfield, in *Mineral Resources of the United States, 1928,* II, 400.

3. Brick and Tile

a. *Common and Face Brick*

The interesting feature of seasonal variations in the flow of brick is the contrast between the common and face varieties (Chart 29). Shipments of both show wide amplitudes, but that for face brick is materially wider than that for common brick. The difference appears to arise from the more restricted use of face brick. As it is utilized primarily for surfacing of buildings, demand for it is more concentrated during limited periods of the year. The patterns in shipments of the two kinds are similar, except that in common brick there is an additional peak in November. The latter may be due to a spurt of activity by common brick mills before some close for the winter, and before the closing of the navigation season.

There are no monthly data for production of common brick, but seasonal indexes for output can be reliably inferred from a comparison of the seasonal measures for shipments and manufacturers' stocks of burned brick. Besides the precision of results usually obtained in numerous derivations of this type, an additional check upon the derived index for production is found in a comparison with the seasonal swing for unburned brick stocks (Chart 29). Since unburned brick is the semi-finished product of common brick plants, the seasonal movements in their stocks may be expected to show fair similarity in pattern to those in production of burned brick. Such correspondence is found.

The seasonal swing in common brick output is much wider than that in face brick, although shipments of the former are characterized by a narrower amplitude than shipments of the latter. This difference is explained by the present technical state of the industry which makes common brick production much more subject to weather conditions than face brick production. The industry is carried on chiefly in small, local plants and still depends upon water transportation. Only a few plants are equipped to run continuously through the year and many close for the winter.[11] Face brick, on the other hand, is a more expensive product turned out by better equipped plants.

[11] *Seasonal Operation in the Construction Industries,* p. 167.

But production of face brick does not entirely escape the influence of weather conditions which affect the ease of obtaining clay and, in some degree, transportation facilities. Indeed, because of these climatic influences upon ease of production, the seasonal pattern in output of both kinds of brick differs appreciably from that in shipments. In both the peak in output occurs after the peak in shipments, and in both there is an appreciable difference in seasonal amplitude between output and outflow. Hence, in both, seasonal variations in stocks play a considerable rôle in making possible the disparity between production and shipments (see computed and derived indexes for stocks of face brick on Chart 29). In both groups stocks are of considerable volume, the ratio during recent years to monthly production or shipments being 2.4 for common and 3.0 for face brick. In both, stocks are large in winter as a result of accumulated production at high levels in the summer and autumn, and low in late spring and in summer; shipments rise earlier than output, forging ahead of the latter as early as December in common and March in face brick.

Seasonal variations in new orders and shipments are highly similar. In common brick the similarity extends to month-to-month changes in the seasonal index (Chart 29). In face brick the primary seasonal peak and trough in new orders precede those in shipments by one or two months.

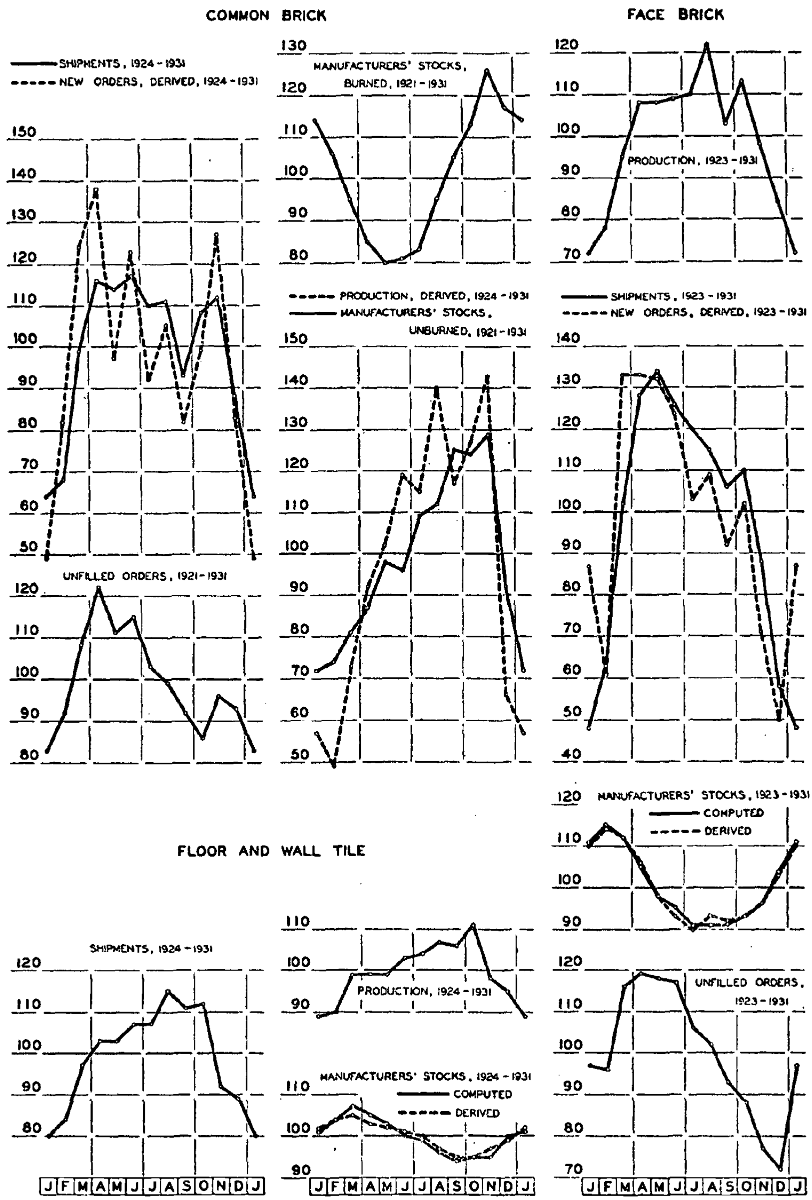
b. *Floor and Wall Tile*

While the primary seasonal peak in shipments of common brick is in June and of face brick in May, that in floor and wall tile shipments is in August, a reflection of the later timing of floor and wall laying operations as compared with that of utilization of brick. The seasonal amplitude is also materially narrower than that in brick, possibly because the laying of tiles is done in the shelter of the completed structure and therefore does not have to be carried through within the limited period of weather favorable to outdoor operations.

The seasonal swing in production is of still narrower amplitude than that in shipments. Here again there is the curious lag of production behind shipments; the primary seasonal peak in the former is in October, again because of the influence of weather on conditions of production. Here again seasonal

CHART 29

SEASONAL MOVEMENT OF BRICK AND TILE



variations in stocks intervene to account for the seasonal disparity between production and shipments (see the computed and derived indexes on Chart 29). And again stocks are large as compared with monthly shipments, the ratio during recent years being 2.5.

4. Lumber

Lumber is the most important construction material, constituting one of the chief materials in a wooden building and a major item of cost in other types of buildings and structures.

Even if brick is used, a six-room house, according to the investigations of the Division of Building and Housing, takes three-fifths the amount of lumber required for frame construction. Furthermore, in building with brick, concrete, and steel, much wood goes into scaffolding and frames. Some systems of concrete construction require more wood than would be the case if wood were the permanent material, and require larger timbers to support the concrete in the process of construction than would the building itself if it were all of wood. It is estimated that 15 per cent of the cost of the concrete construction is lumber.[12]

This statement refers primarily to softwood lumber, of whose total output about 70 per cent is used in construction.[13] Hardwoods furnish only about 6 per cent of the lumber required in building construction of all classes.[14]

a. *Softwood Lumber*

From the standpoint of seasonality in production, softwood lumber may be divided into two groups. The first, at present the more important, includes southern yellow pine and Douglas fir, and is produced in states characterized by mild weather through the year. Thus, of southern yellow pine, which accounts for over 40 per cent of total output of softwood lumber, about 70 per cent comes from Louisiana, Mississippi, Texas, Alabama and Florida, and another 25 per cent from Arkansas, the Carolinas, Georgia and Virginia. It is not surprising therefore to find a very mild seasonal swing in the production of this lumber species (Chart 30). The second group, which includes, among other species, western yellow pine and white

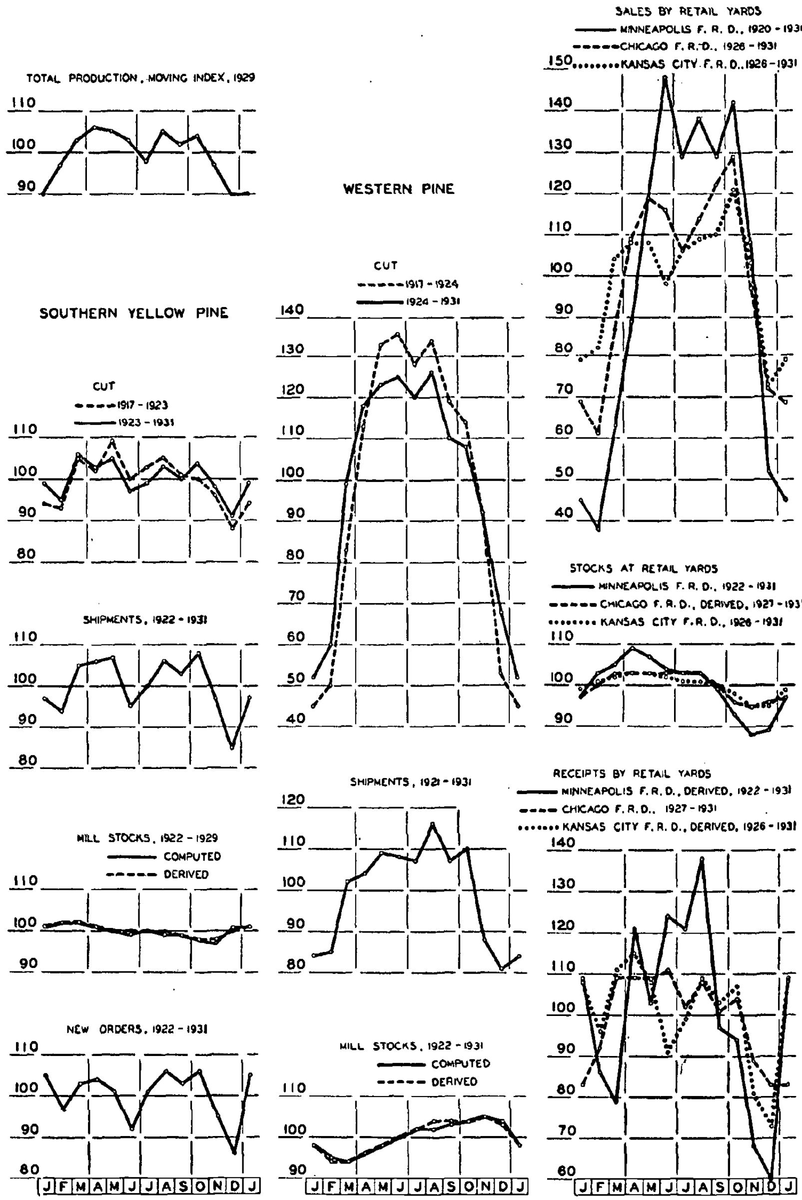
[12] Timber: Mine or Crop, Department of Agriculture, *Yearbook 1922*, p. 137.

[13] *Seasonal Operation in the Construction Industries*, p. 165.

[14] R. C. Bryant, The Lumber Industry, in *Representative Industries in the United States*, p. 494.

CHART 30

SEASONAL MOVEMENT OF SOFTWOOD LUMBER



pine, is produced in states with severe winters which interfere considerably with felling and cutting. Of the most important species in this group, western pine, which accounts for about 9 per cent of the country's output, about 78 per cent is cut in Oregon, California, Nevada, Idaho and Washington. Severe or rainy winter weather in the forest areas of these states is the factor that accounts for the conspicuous seasonal swing in production shown on Chart 30.

Shipments, a stage nearer construction demand for the product, show much less marked discrepancies in amplitude than production. True, shipments of western pine, like output, are subject to a wider seasonal swing than shipments of southern yellow pine. But the smaller difference in amplitude of shipments than in production indicates the limited character of the influence which diverse natural conditions of production exercise upon the seasonality of shipments. Thus, outflow of southern pine is seasonally more variable than output, while outflow of western pine is seasonally less variable than output. In respect to pattern there is an essential similarity between the two stages of commodity flow, and a fairly substantial similarity between the two species.

The seasonal disparity between production and shipments is cumulated into seasonal variations in mill stocks (see computed and derived indexes on Chart 30). These variations are rather mild, but only in southern pine does the mildness arise from small absolute discrepancies between production and shipments. In western pine the relative seasonal swing is greatly reduced by the large volume of stocks. The ratio of mill holdings to monthly shipments amounted during the recent period to 2.6 for southern pine and to as high as 6.8 for western pine.[15]

Because of the different relationship between the seasonal amplitudes of production and shipments in the two lumber species, there is a different relationship between the seasonal patterns characterizing stocks and production or shipments. For southern yellow pine the pattern in stocks is on the whole inverted to that in production and shipments. In western pine the two are correlated positively, the pattern in stocks lagging somewhat at the peak and trough.

[15] For an interesting discussion of stock holdings by lumber mills see R. C. Bryant, *Lumber, Its Manufacture and Distribution* (New York 1922), pp. 275-6.

Seasonal variations in lumber shipments are on the whole rather mild. It seems clear that these indexes of lumber shipments by mills do not reveal fully the seasonal swing that is characteristic of lumber consumption by the construction industry. The latter is shown much more precisely in the movement of lumber through the stages nearest final consumers, namely, wholesalers and retailers.

The regional data available on sales of lumber by retail yards, while yielding indexes varying considerably in amplitude from district to district, do indicate the greater seasonality of these sales as compared with that of shipments by mills (see Chart 30 and Table X). The seasonal amplitude of sales by retail yards in the Kansas City district, the smallest of all, is still appreciably in excess of that of southern yellow pine shipments and somewhat larger than that of western pine shipments.

The seasonal swing in retail sales of lumber is also wider than that in sales by wholesalers. District by district, the comparison shows larger average deviations for the former than for the latter, the most appreciable difference being in the two indexes for the Minneapolis Federal Reserve district, where retail sales show the widest seasonal swing.

This, of course, points clearly to stock holding by retail yards and seasonal variations in these stocks. The stock indexes for each of the three districts show a peak in the spring and a trough in late autumn, an obvious adaptation to the peak sales during summer and early autumn (Chart 30). The seasonal variations in stocks are of narrow amplitude, but stocks are quite large in comparison with monthly sales. During recent years the ratios for the two districts for which data are available were 8.0 in Minneapolis and 7.2 in Kansas City; these are the highest ratios we have so far encountered.

b. *Hardwood Lumber: Floorings*

The analysis of seasonal variations in maple floorings, the most important construction product in the hardwood group, suggests the following comments (Chart 31):

(1) The seasonal swing in the production of maple floorings, like total softwood lumber output, has a narrow amplitude; but it shows an entirely different pattern, with a trough instead of a peak in summer. This is possibly because the raw material, maple, is supplied during the summer, and the manu-

facturing production of flooring must wait upon cutting and seasoning.

(2) Shipments are characterized by a much more conspicuous swing than output, of a pattern similar to that in shipments of floor and wall tile. The similarity is to be expected in view of the probably identical timing of the construction operations utilizing flooring and tiles. Seasonal variations in stocks are naturally of a pattern inverted to that in shipments. These variations are appreciable when the ratio of stocks to monthly shipments during the recent period, 2.6, is considered.

(3) The index for new orders shows a strange pattern, although it is somewhat similar to that in shipments. Judged by the unsatisfactory seasonal correction that it introduces into the original data, this measure for new orders does not appear reliable.

5. Structural Steel, Roofing Materials and Paint

a. *Steel*

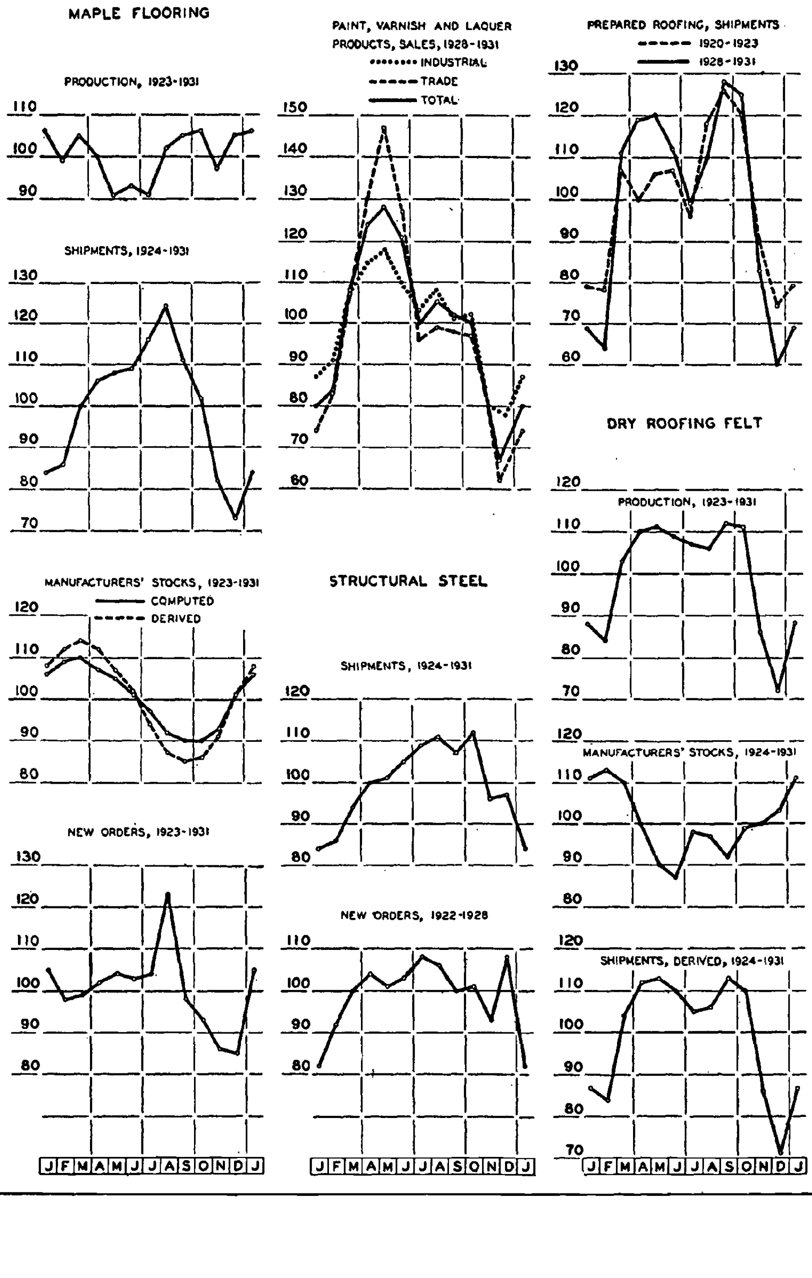
The seasonal patterns of both shipments and new orders of structural steel are in line with similar patterns for other construction materials, except possibly for the curious second peak in new orders in December (Chart 31). Also, the lag of the peak in shipments behind that in new orders is in agreement with results of other similar comparisons. The new element in the present case is the narrower amplitude of the swing in new orders, an exception to the generally observed wider seasonal amplitude of new orders as compared with shipments.

The reasons for this exception may be: (1) Shipments of structural steel are arranged so that delivery will be near the time of utilization in the construction operations. This policy, which developed from the difficulty of storing the bulky product, would, because of the seasonality of construction operations, bunch shipments in certain months; (2) Water transportation facilities may be utilized for shipments of such heavy products as structural steel, with consequent limitation upon the period favorable to shipments. Neither of these factors is, of course, of similar influence upon new orders.

The mildness of the swing in the latter, as compared with that in orders for other construction materials, may be attributable to the use of steel primarily for construction projects

CHART 31

SEASONAL MOVEMENT OF FLOORING, STEEL, ROOFING AND PAINT



which, because of their magnitude and the expense of delay, tend to be carried out at a relatively even rate throughout the year. Moreover, orders for steel, with their precision in specification and timing, are less subject to the influence of customary dates than are orders for commodities in which cancellation is a more accepted practice.

b. *Roofing Materials*

The interesting feature of seasonal variations in the production and shipments of roofing materials is the seasonal pattern, which, in contrast to those for other construction materials, has two peaks, one in May and the other in September (Chart 31). The reason apparently lies in the extensive utilization of roofing materials both for renovation of existing buildings and for new construction; a considerable part is consumed also in summer buildings. Most renovation, as well as work on summer buildings, is done in the spring, while the demand for roofing materials for new, year-round buildings is at peak in the autumn.

Another notable feature is the closeness with which production of dry roofing felt adjusts itself to shipments. The ratio of producers' stocks to monthly production is only 0.2, which means that holdings average about 5 days' output.

c. *Paint*

The use of paint chiefly for renovation and repairs accounts for the preponderance of the spring peak in sales by manufacturers.[16] While sales do not decline below the annual average until November, the greater use of paint in the spring renovation of buildings, perhaps augmented by demand on the part of the automobile and transportation trade and agriculture, causes higher levels in April, May and June than prevail in the autumn as a result of use in connection with the completion of new buildings.

Seasonal patterns of sales to industrial consumers and to the trade are very similar, but the amplitude of the former is markedly milder than that of the latter. The difference may arise from two sources: (a) the greater seasonality of the demand which is satisfied by the trade, since industrial consumers, in contrast to private consumers, find more continuous

[16] ". . . . more than 75 per cent of all painting work is performed on existing structures." *Seasonal Operation in the Construction Industries,* p. 175.

use for paint and lacquer products throughout the year; (b) the purchasing policy of the trade, which buys heavily in the spring, and in the winter lets stocks run low, even in relation to the diminished demand.

6. Radiators and Boilers

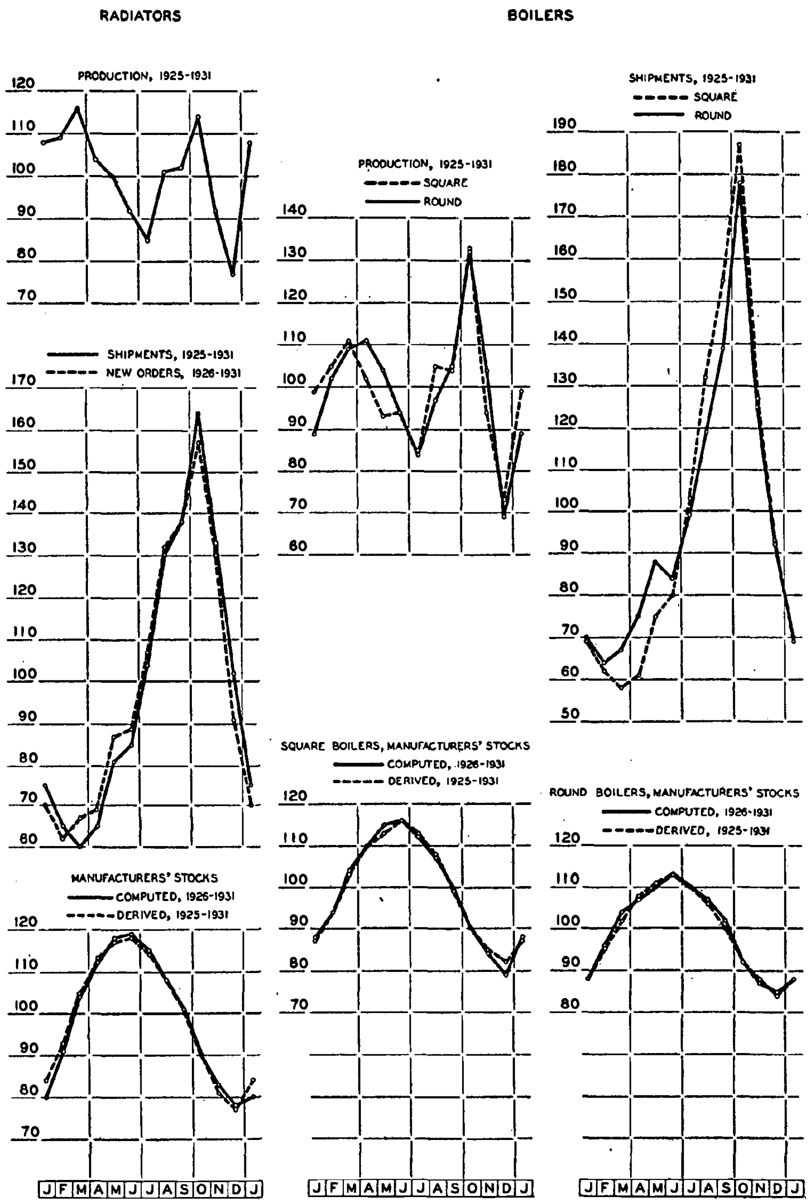
The strikingly wide amplitude of shipments of both radiators and boilers is clearly shown on Chart 32. Similarly wide amplitudes were found above in the shipments of Portland cement, asphalt and face brick. But the conspicuous character of the swing in these was attributable to the fact that a large proportion of the product is utilized in such seasonally variable outdoor operations as construction of roads or work on the surface of buildings; radiators and boilers, on the other hand, are used primarily in connection with buildings and where installation takes place in the shelter of a structure, even though the latter may not be entirely completed.

The reasons for the wide seasonal amplitude of shipments in the present example must, therefore, be sought elsewhere. The following tentative explanations may be suggested: (1) For radiators and boilers, still more than for structural steel, there is an incentive for arranging shipments so as to have the products arrive shortly before the time of installation. Since radiators and boilers are bulky and susceptible to deterioration from exposure, the possibility of storage by contractors is rather limited. Moreover, shipments, as in the case of steel, are generally direct from manufacturer to final consumer. (2) The patterns of both replacement and original demand for the product are approximately the same, the peak in both occurring shortly before the advent of cold weather.

The variation in production is quite different from that in shipments in respect of both amplitude and pattern. The amplitude is much narrower, the average deviations running less than half those for shipments (Table X). The pattern, while retaining a conspicuous high point in October, shows another in March or April, which for radiators is even higher. The double-peak pattern in the output of radiators and boilers is similar to that characteristic of several other branches of manufacturing production and is partly a statistical result of the variation in the number of working days in the month, partly a result of the vacation letdown during the summer. It

CHART 32

SEASONAL MOVEMENT OF RADIATORS AND BOILERS



is true, though, that the seasonal amplitude in production of this particular group of commodities is wider than that for most other branches of manufacturing.

The difference in pattern and amplitude between output and shipments is an expression of the producers' policy of keeping manufacturing processes comparatively free from disturbance by the seasonality of purchases on the part of the construction industry. This seasonality is reflected largely in stock holdings, and we do find marked seasonal variations in manufacturers' stocks, the latter cumulating during winter and spring to a peak at the end of June, and declining to a trough at the end of December. The volume of stocks is also large, the ratio to monthly shipments during the recent period amounting to 4.7 for radiators and 5.9 each for square and round boilers. Multiplying these ratios by the average deviations of the corresponding seasonal indexes, we obtain the following approximate measures of significance of seasonal change in stocks: 61 for radiators, 58 for square boilers and 52 for round boilers. These measures are greater than for any stocks of construction materials discussed in this chapter, not excluding even lumber holdings by retail yards.

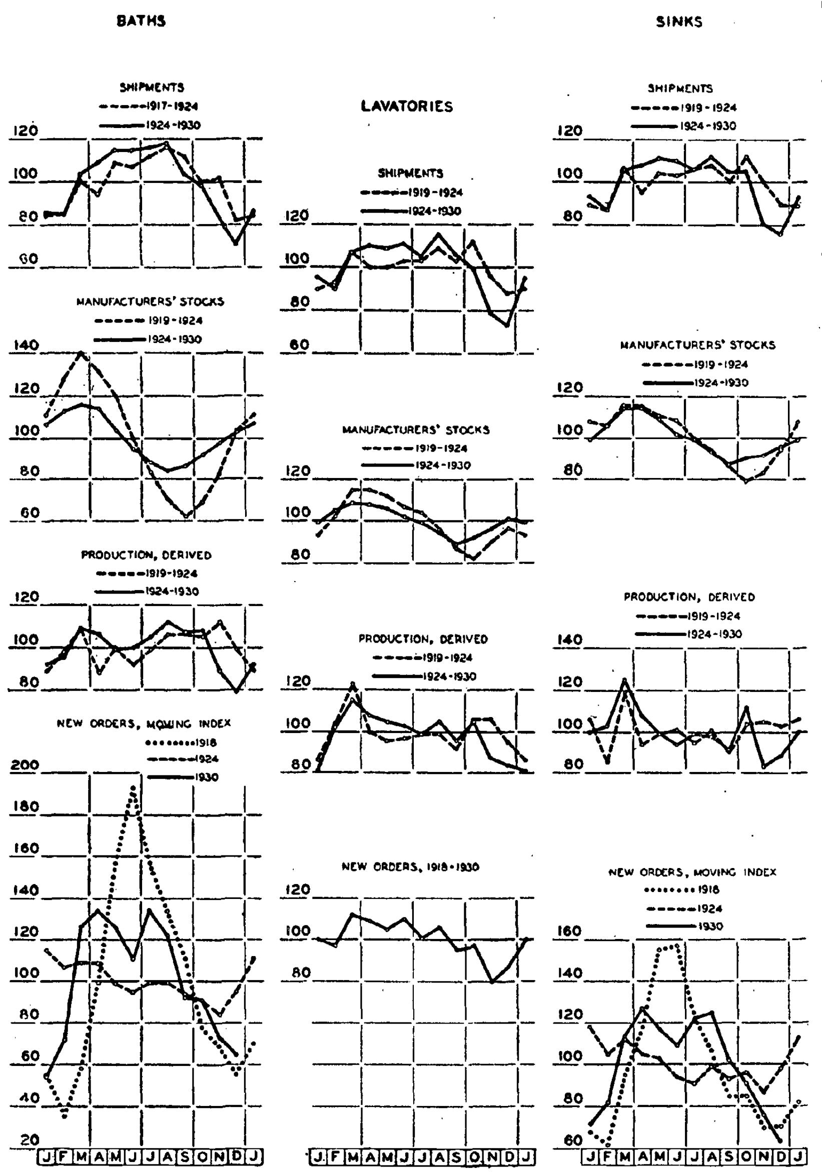
7. Sanitary Wares

Shipments of such sanitary wares as baths, lavatories and sinks are subject to rather mild seasonal variations, as construction materials go (Chart 33). The reason is that these products are used in connection with buildings only, and that two of them, sinks and lavatories, are used in residential, public and all business buildings. Shipments of baths, used in residential buildings primarily (including hotels), show period by period wider seasonal amplitudes than those of sinks and lavatories (Table X).

Although data on production are lacking, seasonal indexes can be derived from those for shipments and manufacturers' stocks. The measures thus obtained cannot be relied upon for a close study of the pattern, but the fact that the amplitudes are generally narrower than those characterizing shipments appears significant. The comparison in Table X indicates that only for baths in the early period is the average deviation in production in excess of that for shipments. The greater stability of output as compared with shipments, when the pro-

CHART 33

SEASONAL MOVEMENT OF BATHS, LAVATORIES AND SINKS



duction process is free from seasonal disturbances of its own, is true also for this group of construction materials.

The changes from period to period in the seasonal amplitude of production, shipments and producers' stocks of sanitary wares are quite similar to those observed for Portland cement. As in the latter, the swing in production and shipments has widened in amplitude from the first to the second post-War period; the seasonal amplitude of stocks held by manufacturers has narrowed from the earlier to the later period; the change is due largely to the rise in the ratio of stocks to monthly shipments. This ratio increased between the earlier and the later periods from 0.8 to 1.4 for baths, 1.2 to 2.2 for sinks, and 1.2 to 1.9 for lavatories.

Temporal changes are, however, most marked in seasonal variations of new orders. Only for lavatories is it possible to establish a constant seasonal swing in new orders. For baths and sinks moving seasonal indexes have to be computed. Chart 33 presents indexes for each of these groups for three years, chosen to illustrate the influence of changing business conditions upon the seasonal variation. Thus in 1918 new orders for baths showed an enormous seasonal swing. The peak occurred in June, that is, about two months before the peak in shipments, while the trough was in February. This was a year of uncertain business conditions when building activity was in a cyclical trough. The few orders made were placed shortly before the commodity was required for use, consequently during the out-of-season months the volume of orders was very small.

The seasonal movement of new orders for baths in 1924, a peak year in building activity, was markedly different. Orders were highest in January, declining to a trough in November. Thus, under conditions of accelerated construction activity orders were given as early as possible, the peak preceding the peak in actual installation by about six or seven months. In addition, orders were not reduced as drastically as in 1918 during out-of-season months. As a result, the average deviation is much smaller than that for 1918.

The seasonal pattern for 1930 resembles that for 1918. Since 1930 was a year of low levels of construction, following a marked cyclical decline, orders again show a rather large seasonal variation.

The moving seasonal index for new orders of sinks changed almost exactly as did that in orders for baths (Chart 33).