ENGINEERING ECONOMY AND ENERGY CONSIDERATIONS

ASPHALT CONCRETE PRICE ESCALATION

RESEARCH REPORT 214-15

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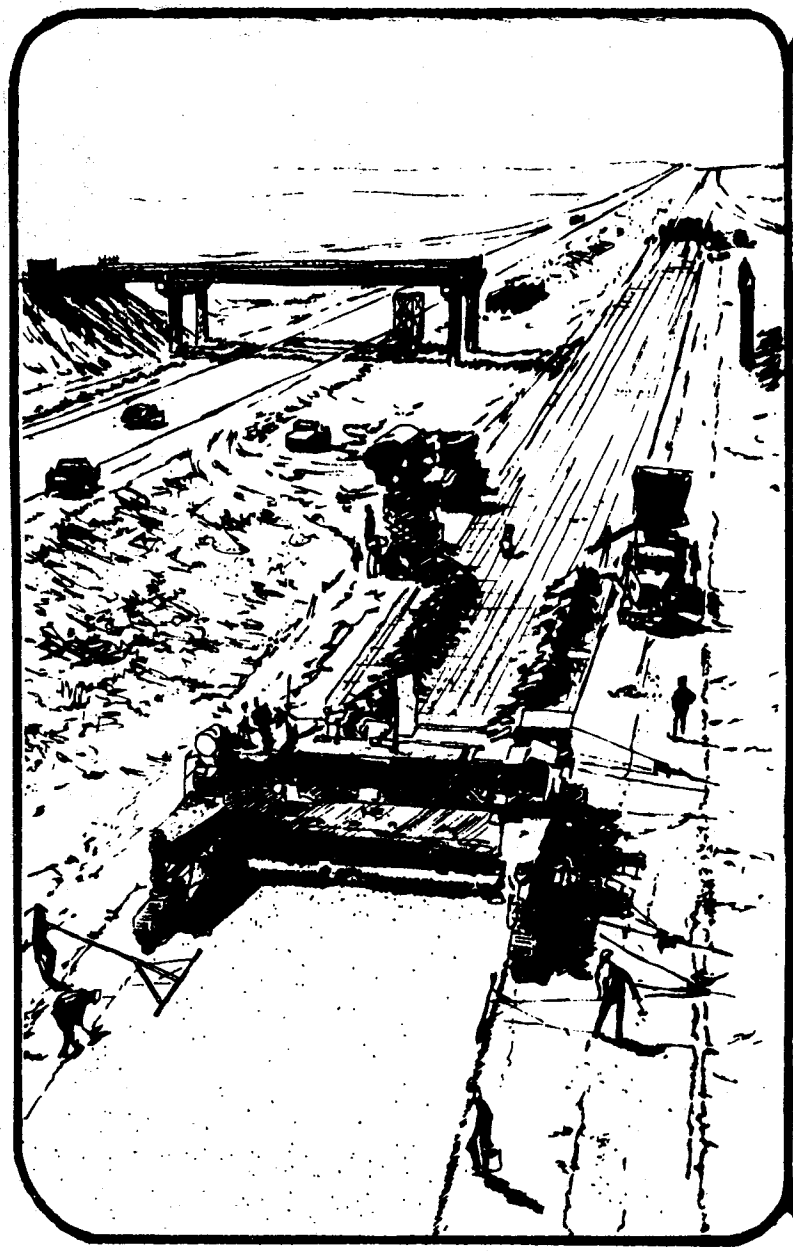

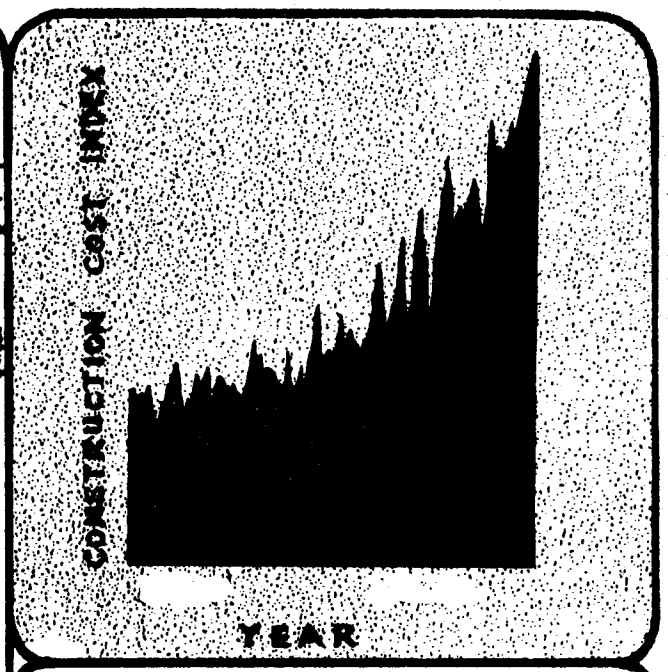

COOPERATIVE RESEARCH PROJECT
2-9-74-214

"ENGINEERING, ECONOMY AND ENERGY CONSIDERATIONS IN DESIGN, CONSTRUCTION AND MATERIALS"

TEXAS STATE DEPARTMENT
OF HIGHWAYS
AND PUBLIC TRANSPORTATION

AND

TEXAS TRANSPORTATION INSTITUTE
TEXAS A&M UNIVERSITY

STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

TASK FORCE ON ENGINEERING, ECONOMY AND ENERGY CONSIDERATIONS

Larry G. Walker, Task Force Chairman and Materials and Tests Engineer

Charles H. Hughes, Sr., Study Contact Representative and Assistant Materials and Tests Engineer

A.H. Pearson, Jr., District Engineer

Wayne Henneberger, Bridge Engineer

Robert L. Lewis, Chief Engineer, Highway Design

Byron C. Blaschke, Chief Engineer, Maintenance Operations

J.R. Stone, District Engineer

William V. Ward, Urban Project Engineer-Manager

Phillip L. Wilson, State Planning Engineer

Franklin C. Young, District Engineer

Theodore E. Ziller, Construction Engineer

ASPHALT CONCRETE PRICE ESCALATION

by

Jon A. Epps* and C. W. Smoot**

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Study 2-9-74-214
Engineering, Economy and Energy Considerations
in Design, Construction and Materials

Sponsored by the
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*Research Engineer, Texas Transportation Institute, Texas A&M University, College Station, Texas

**Executive Director, Texas Hot Mix Asphalt Pavement Association, Austin, Texas

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INTRODUCTION

Since the initiation of cooperative research project 214 in 1974, the project staff has monitored construction price trends for the key construction materials of asphalt concrete, portland cement concrete, reinforcing steel, structural steel, structural concrete and common excavation. A 1977 presentation of these data to the task force responsible for project guidance and to Texas State Department of Highways and Public Transportation (SDHPT) area research committees indicated that additional study was warranted (Figure 1) (1). Specifically, the project staff was asked to develop information which would provide an understanding of the following basic questions:

1. Why has the price of asphalt concrete escalated more rapidly than the general inflation rate of the United States economy?
2. Why has the price of asphalt concrete escalated more in Texas than adjoining states and the United States average?
3. How can the price of asphalt concrete be reduced?
4. What are the expected future price trends for asphalt concrete?

DEFINITION OF PROBLEM

Figure 1 illustrates the price trend for asphalt concrete in the United States, Region 6 of the Federal Highway Administration (Arkansas, Louisiana, New Mexico, Oklahoma and Texas) and for the State of Texas. Review of this figure and Table 1 indicates that the price of asphalt concrete in Texas was nearly identical to or less than the average price

of asphalt concrete in the United States during the years 1968 and 1971. Prior to 1968 Texas prices were in general less than the average price in the United States. However, since 1971 price increases in Texas have been greater than the average in the FHWA Region and the United States. For example, Table 2 indicates that the annual increase in asphalt concrete has been 17.2 percent in Texas as compared to 11.5 percent for the United States during the period 1973 to 1978. For the period 1968 to 1978, the Texas price has escalated 15.6 percent, Oklahoma 12.5 percent, Louisiana 10.2 percent, Region 6 11.7 percent and the United States 9.7 percent.

The rapid cost escalation of asphalt concrete throughout the United States is typical of most construction material. Annual cost escalations for selected construction items between the years 1973 and 1978 are shown in Table 3. It is interesting to note that only common excavation escalated more rapidly than asphalt concrete.

Typical annual cost increases for a variety of consumer commodities are shown in Table 4. By comparing Tables 3 and 4 it is evident that average annual construction price increases have been greater than those associated with typical consumer goods (2). For example, the average annual price increase for asphalt concrete for the years 1973 to 1978 in the United States is 11.5 while the Consumer Price Index has escalated an average of 8.0 percent annually during this same period. Energy related consumer goods have, however, escalated at a rapid average annual rate.

Price increases associated with specific Texas hot mix producers are shown in Tables 5, 6, 7 and 8. The data in Table 5 were obtained from a

major producer in an urban area of Texas. Table 6 data were furnished by a producer in east Texas and Table 7 data were furnished by a producer in north Texas with plants in a rural and urban area. Table 8 contains data from three west Texas hot mix producers. The data presented in these tables indicates a price index increase of about 220 or an average annual price increase of about 17 percent from 1973 to 1978. Price index increases in urban areas are in general larger than those in the rural areas.

A review of the information presented above indicates that asphalt concrete prices have escalated more rapidly than the general inflation rate of the United States and that the price of asphalt concrete has escalated more in Texas than adjoining states and the United States average. If costs are to be reduced in Texas, it is important to understand the reasons for these discrepancies.

STUDY APPROACH

In order to obtain data for development of an understanding of the questions posed in the introduction of the study, the staff reviewed available published data from a number of sources including; the Texas Railroad Commission, Texas SDHPT, Federal Highway Administration, U. S. Department of Labor, U. S. Department of Energy, National Asphalt Pavement Association, First City Bank Corporation of Texas, Engineering News Record, and U. S. News and World Report. In addition, twenty Texas contractors, five material suppliers and three state asphalt pavement associations were interviewed.

The twenty Texas contractors interviewed have 48 hot mix plants and produced 5,000,000 tons of hot mix in 1978. Contractors were selected such that representation would be obtained for the following groupings.

1. Size of hot mix operation (1 plant to 13 plants)
2. Rural or urban location and market
3. Produced as little as 25 percent to as much as 100 percent for State utilization
4. Geographical region
5. Owners of batch and drum plants

It is estimated that about 2,600,000 of the 5,000,000 tons produced by the contractors interviewed were used on state projects. This represents about 75 percent of all hot mix used by the Texas SDHPT in 1978 (Figure 2).

Typical end use of hot mix produced in Texas and the United States is shown on Tables 9, 10 and 11 (3, 4). Table 9 indicates that the amount of hot mix used for resurfacing has increased 16 percentage points from 1965 to 1976 in the United States. This trend away from new construction is expected to continue in the United States. It is interesting to note that only 31 percent of the total 1976 Texas production of hot mix is used for resurfacings while the United States average is 53 percent (Table 9). The population growth of Texas has contributed to this observed difference.

Table 10 shows the market distribution of hot mix for interstate highways, state highways, municipal and county roads, airports and private and commercial work for both the United States and Texas in 1975 and 1976. Again, the 1976 figures indicate the relatively large proportion of hot mix

that is utilized by local road authorities as well as private and commercial uses. The population growth and the resulting demand for housing, goods and services probably accounts for this difference.

Table 11 illustrates the market distribution for a south Texas producer. A substantial portion of the 1976 production was used for other than Texas SDHPT use.

ASPHALT CONCRETE PRICE ESCALATION

Economic conditions which have affected inflation and shortage in the United States have been recently summarized by Wootan (5) and are listed below:

1. Shortage of capacity
2. Devaluation of dollar
3. Government spending, monetary policy and interest rates
4. Reduced domestic reserves of raw materials
5. Wage and price controls
6. Oil embargo
7. Shortage of capacity in some areas of construction industry
8. Uncertainty and risk associated with world and domestic economy and with government economic policy and regulations
9. Supply allocation policies resulting from shortage
10. Environmental and safety regulations

The impact of these conditions on construction costs is in all probability more pronounced than on consumer goods costs. For example, 45 percent of the highway dollar is expended on materials and supplies. Many of these

materials are not only energy intensive to produce but also energy intensive to place. The cost of energy has escalated at a much faster rate than other individual commodities (Tables 3 and 4). In addition, material shortages are more likely to affect the cost of construction materials than most consumer goods.

In order to more fully understand cost escalation associated with asphalt concrete, data obtained from interviews with contractors has been summarized. As a starting point for this discussion, the component cost of asphalt concrete is presented.

Component Cost of Asphalt Concrete

Eleven Texas contractors supplied information which allowed the calculation of production component costs (Table 12). Approximately 70 percent of the FOB plant price for asphalt concrete can be attributed to materials (asphalt cement plus aggregate). Forty percent of this materials costs can be attributed to the cost of asphalt cement and 60 percent to aggregate. Energy costs are about 5 percent while mixing costs are about 13 percent. Two percent of the costs are for taxes, insurance, dues, bonds, office supervisors, etc. Profits of about 10 percent are expected based on these data.

Six Texas contractors supplied data which allows for the calculation of component costs for in-place asphalt concrete (Table 13). About 53 percent of the in-place cost can be attributed to material costs. Energy costs are about 4 percent, mixing costs about 11 percent, haul laydown and compaction about 18 percent, miscellaneous items about 2 percent and

profits about 12 percent. Table 14 is a summary of in-place component costs for hot mix developed by three separate investigators in the early 1970's (6, 7, 8). Material costs have escalated by about 5 to 10 percentage points since these earlier investigations conducted prior to the 1973-74 oil embargo.

Table 15 gives a more detailed cost breakdown of FOB plant component costs for a Texas contractor during the years 1974 to 1978. From these data it is possible to calculate individual cost component increases. These are shown on Table 16. Electric utilities, aggregates and asphalt cement have increased the most as repairs should not be realistically assigned to only one year as an expense. Ownership expenses and miscellaneous expenses have decreased and drier fuel has increased only a small amount as the plant changed to a different type of burner fuel. The cost of burner fuel has increased significantly in the last 12 months.

Asphalt Cement. Tables 12, 13, 14 and 15 indicate that material costs are the largest portion of the total cost of asphalt concrete. Asphalt cement is 25 to 30 percent of the FOB plant price and about 20 percent of the in-place price. Increases in the cost of asphalt cement will have a significant impact on the cost escalation of asphalt concrete.

The escalation of the posted price of asphalt cement at a Houston refinery is shown on Table 17 and Figure 3. The price index increase between 1973 and 1978 is 188 which equates to an annual average price increase of 13.5 percent for this period. This compares with an index increase for asphalt concrete in the United States of 172 and 220 for Texas during the same period (annual average price increase of 11.5 and 17.2 percent, respectively).

Table 18 shows the FOB refinery price of asphalt cement in various

United States cities (9). As noted, the price of asphalt cement in Houston is typical of prices in the United States.

Table 19 indicates that asphalt cement is 12 to 33 percent lower in cost than other petroleum binders used in pavement construction. Table 20 indicates that the price of gasoline has increased at an annual rate of approximately 12 percent during the 1973 to 1978 period (10).

The data presented above indicates that for each 10 percent increase in the price of asphalt cement, the price of a ton of asphalt concrete in-place will increase by about 2 percent. Price increases associated with asphalt cement are typical of those experienced by other petroleum based products and can be related to crude oil acquisition price.

Aggregates. Aggregates are about 40 percent of the FOB plant costs and about 33 percent of in-place price of asphalt concrete. Increases in the cost of aggregates will have a significant impact on the cost escalation of asphalt concrete.

Tables 21 and 22 show typical aggregate price index escalations in Texas. Index escalations of the order of 150 to 200 (average annual price increases of 8 to 25 percent) are evident for the period 1973 to 1978. This compares with an index increase for asphalt concrete in the United States of 172 and 220 for Texas during this same period (average annual price increases of 11.5 and 17.2 percent, respectively).

The data presented above indicate that for each 10 percent increase in the price of aggregate, the price of a ton of asphalt concrete in-place will increase by about 3.3 percent.

Energy Costs. The cost of heating and drying aggregates and for utilities at hot mix plants is about 5.3 percent of FOB plant price and about 3.9 percent of the in-place price of asphalt concrete (0.70 to 1.00

dollar per ton). For the period 1973 to 1978 the cost index for natural gas for home heating has increased to 207 (15.6 percent average annual price increase). (Table 4) The price index increase for diesel in one location in Texas is 410 for the 1973-1978 period (32.6 percent average annual price increase). A Texas hot mix producer has held the index to 115 (3 percent average annual price increase) during the 1973-1979 period by changing fuels (Table 16). The cost of fuel to heat aggregate for one ton of asphalt concrete for the years 1970 to 1978 is shown in Table 23 for a second Texas contractor. A price index increase of 400 (32 percent average annual price increase) was experienced between 1973 and 1978 for this producer.

An increase of 10 percent in the price of energy will increase the price of a ton of asphalt concrete in place by about 0.4 percent.

Mixing. The cost of mixing asphalt concrete including labor, equipment depreciation and maintenance is about 14 percent of FOB plant prices and about 11 percent of the in-place price of asphalt concrete. For the period 1973 to 1978 the cost index for mixing at a Texas hot mix plant has increased to 110 (2 percent average annual price increase). Construction equipment costs however have increased significantly during this period. For example, equipment for hot mix production and laydown (plant, laydown equipment, 4 trucks and rollers) could be purchased for about 1,000,000 dollars in 1976. The cost of equivalent equipment today is 1,500,000 dollars. Certain items of heavy equipment have escalated at an average annual rate in excess of 40 percent during the period from 1973 to 1978.

An increase of 10 percent in mixing will increase the price of a ton of asphalt concrete in-place by about 1.1 percent.

Haul, Laydown and Compaction. The cost for hauling the hot mix from the plant to the paving site, laydown and compaction is about 10 percent (2 to 4 dollars per ton) of the in-place price of asphalt concrete. Cost escalation data for the period 1973-1978 were not obtained in the study. However, these costs are largely dependent upon labor, equipment and haul cost (Table 24). A discussion of transportation costs is presented below.

Miscellaneous Costs. Miscellaneous costs including taxes, insurance, dues, bonds, office, etc. have probably increased in the last several years. Since the cost is relatively small (2 percent) in relationships to other in-place costs detailed information was not obtained.

Mark-Up. Mark-up or profit is of the order of 10 percent. The desired mark-up is 15 percent. Several producers presented data which indicates the profits were as low as three percent and as high as 20-25 on selected jobs. The desired mark-up will in general be larger than the rate of return which can be obtained in secure stocks, bonds, or short term money market certificates. Presently these returns are of the order of 14 to 16 percent.

Transportation

The price index for rail transportation of nonmetallic minerals and clay, concrete, glass or stone in the United States is shown on Figure 4 (10,11). The price index escalation from 1973 to 1978 is 170 (11.3 percent average annual price increase) (11). The price index for rail and truck transportation of sand and gravel in Texas is shown on Figure 5 (12). Price index escalation for the period 1973 to 1978 is 166 for rail and 174 for truck transportation (average annual price escalations of 10.7 and 11.8 percent respectively.

Table 25 shows rail and truck transportation charges from various aggregate sources that produce material for use in Houston's hot mix plants. The difference between truck and rail delivery can be in excess of 4 dollars per ton for aggregate delivered at the hot mix plant. The increased cost associated with rail car unloading as compared to truck unloading contributed to this cost.

Typical truck haul costs reported by Texas producers for aggregates are 7 to 10 cents per ton mile. Hot mix haul costs are typically 10 to 15 cents per ton mile. In urban areas trucks are often contracted by the hour. Trucks with legal hauls of 12 tons are receiving 20 to 25 dollars per hour. The requirement to haul legal loads on trucks will probably increase trucking costs on the order of 20 to 40 percent or increase costs for example from 10 cents per ton mile to 12 or 14 cents per ton mile.

The difference between rail delivery and truck delivery of aggregates will create cost increases on the order of 10 to 12 percent per ton of hot mix produced. The availability of rail cars is vital if additional escalation due to transportation costs in select urban areas is to be controlled. Transportation costs for hot mix in-place can easily account for 30 percent of the total in-place cost of asphalt concrete and may be as much as 50 percent.

Summary

Table 26 contains a summary of information presented in this section of the report. Increases in average annual price for the various components have been estimated from data reported herein and combined to predict an average annual price of 13.7 percent for asphalt

for the 1973-1978 period. Data contained in this report indicate an average annual price increase of 11.5 for the United States and 17.2 for Texas. It is interesting to note that component indexes for aggregates and energy are in excess of that for asphalt concrete while the labor and equipment intensive operations of mixing, and laydown are low. The price increases for asphalt concrete in Texas can be largely justified based on increased material, energy and transportation costs. The contractor managed operations have not increased in cost at the same rate as other costs.

COST DIFFERENCES--TEXAS VERSUS NEIGHBORING STATES

Price differences between hot mix in Texas and neighboring states are shown in Table 1. Reasons for these differences have been suggested by state hot mix association executive directors and Texas contractors who work in neighboring states. Potential reasons are listed and briefly explained below:

1. size of job
2. production
3. uniform demand for hot mix
4. time delay between bid and construction dates
5. job carry-over from one construction season to the next
6. separate bid items for mobilization, tack coat and traffic control
7. escalation clause
8. end result specification
9. state wide uniformity of inspection
10. haul costs
11. air quality control requirements
12. aggregates

Size of Job

The average size of a Texas hot mix job in 1978 was about 5,000 tons with about 70 percent of all jobs less than 10,000 tons and about 85 percent less than 20,000 tons (Figure 6). Typical jobs are 130,000 tons in Louisiana. These Louisiana projects are normally thick overlays. Small projects in Oklahoma are considered to be about 7,000 tons with average jobs of about 60,000 tons.

Larger job sizes afford the opportunity to move plants, use locally available materials, and increase production. Plant move-in costs have been reported to be from 13,000 to 40,000 dollars by Texas contractors. An average representative cost is about 20,000 dollars. (Move-in costs in Arkansas have been reported to be 5 to 10,000 dollars lower in cost than in Texas). Texas plant average move-in costs amount to 2 dollars per ton for a 10,000 ton job or 20 cents per ton for a 100,000 ton job. For small jobs it is often more economical to haul the hot mix and not relocate the plant (Figure 7). Haul costs can however be substantial. For example, a 40-mile hot mix haul at 15 cents per ton mile will cost 6.00 dollars per ton. If a plant can be moved for 20,000 dollars, it will be cost effective to relocate the plant if the project is larger than about 3,500 tons. However, if the plant cost 40,000 dollars to move, the project must be in excess of about 7,000 tons (Figure 7). (These figures assume that aggregate haul costs are about equal for all plant locations).

From an energy conservation standpoint haul distances should be minimized by moving the hot mix plant.

Production

Larger tonnage jobs afford the opportunity for higher rates of plant production. Fixed daily operating costs of from 6,000 to 10,000 dollars per day have been reported by Texas contractors. These costs include labor, equipment, maintenance, traffic control, miscellaneous materials and overhead for both production and laydown. Figure 8 can be used to calculate the influence of daily production on the cost of asphalt concrete. For a daily operating cost of 8,000 dollars, the operating cost per ton for a daily production of 500 tons is 16 dollars; for a daily production of 1000 tons, 8.00 dollars; and for 1500 tons, 5.33 dollars. Thus a savings of about 25 percent per ton of hot mix can be achieved by increasing production from 500 to 1,000 tons per day.

Other items which have been identified by contractors and which will contribute to increased daily production include:

1. paving a full 24 foot width when practical
2. sequencing construction such that asphalt concrete surfacing materials can be placed immediately after placement of the black base
3. allow overnight longitudinal joint exposure where practical
4. allow thick lift construction where practical

Uniform Demand for Hot Mix

The demand on both a state wide and regional basis is constantly monitored in Louisiana by both state and hot mix association personnel to insure that demand does not greatly exceed production. In addition demand is controlled as well as possible to insure that large variations do not occur from year to year. Figure 2 illustrates the large variation in Texas

SDHPT demand for hot mix for the years 1972 to 1978. Figure 9 and Table 27 show the variation of asphalt cement demand in Texas for the years 1967 to 1978. A like variation in hot mix production will be associated with the variation in asphalt cement. This non-uniform demand has created a variable market split for many Texas contractors (Table 11) as well as low profit years followed by years where the capacity to produce hot mix has not been equal to demand.

Texas contractors can normally be expected to obtain a 10 to 15 percent profit. If the producer has an excess of work, the profit will often be bid at 25 to 35 percent. If contractors need work, many will settle for a 5 percent profit while others are willing to take a 5 percent loss in order to maintain their labor force and continue to cover equipment depreciation costs.

Time Delay Between Bid and Construction Dates

Most jobs in Louisiana are let in January and February and are under construction prior to July. Only about 10 to 15 percent of jobs are carried through the winter. The normal Oklahoma project is let and under construction within one month. Very few jobs are "carried over".

Data is not currently available on the percent of jobs that are carried over in Texas. Short time delays between letting and construction reduce the uncertainty associated with inflation.

Separate Bid Items

Oklahoma and Louisiana have separate bid items for mobilization, tack coat and traffic control. Tack coat costs are typically 40 to 75 cents per ton of hot mix placed. Mobilization can be high as 40,000 dollars if a plant

must be moved. Traffic control can cost as much as 8 to 10,000 dollars for a job or 1.00 to 1.50 per ton.

Escalation Clause

Louisiana has a price escalation clause for asphalt cement. This price adjustment method reduces uncertainty. Consequently contractors are not required to anticipate future asphalt cement prices in their bids.

End Result Specification

Louisiana utilizes an end result specification. The contractors are able to obtain higher daily production as delays due to state inspectors are minimized. Most contractors use private laboratories or have established their own laboratories to achieve the desired control. Final acceptance testing is retained by the state.

Uniformity of Inspection

The control and acceptance of hot mix is more centrally controlled in Arkansas, Louisiana and Oklahoma than in Texas. The practice of increasing prices when working for certain districts and/or resident engineers appears to be minimal in these states. Texas contractors have indicated that from 5 to 25 percent price increases have been included on jobs in certain districts and/or residencies. A 15 percent increase was often reported. Some Texas contractors have stated that they will not bid jobs in certain districts or residencies.

Haul Costs

Larger haul units are allowed for laydown operations in neighboring states. Two Texas contractors report savings of 3 cents per ton mile could be achieved if larger haul units were allowed for laydown operations in Texas. For a 33 mile haul this amounts to 1.00 per ton or about a 4 percent savings on the in-place cost of hot mix.

Texas truck rates in February of 1979 were about 60 percent more than Oklahoma rates. This rate difference has created truck availability problems in Oklahoma as the trucks are often working in neighboring states. Texas contractors have indicated that current truck rates in Texas appear to accurately represent the cost of operation, ownership and maintenance of this type of vehicle.

Air Quality

Based on interviews with state hot mix executives, air quality control requirements in Texas are more stringently enforced than in neighboring states. A Texas contractor reported that from 2.5 to 3.5 percent of in-place costs can be associated with air quality control. The overall cost of government regulations (as reported by Texas contractors) is in the range of 5 to 35 percent of the cost of hot mix.

Aggregates

Texas in general requires that coarse aggregates be placed in more than one stockpile. Arkansas requires only a single stockpile for coarse aggregate, thus a savings of 1 to 3 dollars per ton of aggregate can be anticipated.

Oklahoma uses about 45 percent plus No. 10 sieve material while 65

percent plus No. 10 is required on some Texas jobs. A potential savings of 2 dollars per ton can be expected in some areas of Texas if the requirement for plus No. 10 material is reduced. Oklahoma has used hot sand mixes in many areas.

Oklahoma allows the blending of acceptable coarse aggregates to meet skid resistance. Louisiana approves aggregates by source for skid resistance purposes. Some but not all areas of Texas blend aggregates to achieve skid resistance.

Polish value requirements are used to control surface course friction requirements in Texas. The cost of providing aggregates that meet polish value requirement is substantial in many parts of the state and has amounted to as much as 10 dollars per ton. Typical cost increases are 3.00 to 6.00 dollars per ton. The primary difference in cost is in aggregate haul with some increase in equipment maintenance and heating and drying costs.

Aggregate cost increases in Texas due to use of the soundness and decantation test have also been experienced in several districts. Certain aggregates will meet polish value requirements but will not meet soundness value requirements. Other aggregates meet soundness value requirements but do not meet polish value requirements. These costs increases have amounted to 7 dollars per ton on certain jobs.

Inflation and Material Shortages

Inflation in certain areas of Texas (as measured by the consumer price index) has increased at a more rapid rate than the United States average. For example, the 1978 consumer price index for Houston SMSA is 208.2 while the United States average is 195.4. The index for the Dallas-Fort Worth SMSA is 194.0 (14). This higher rate of general inflation contributes to the observed price differences between Texas and neighboring States.

Aggregate shortages and lack of availability of transportation (both trucks and rail cars) have contributed to the rapid escalation in the price of aggregates in Texas. Since hot mix prices are largely determined by the price of aggregate, hot mix prices have escalated disproportionately.

Bid Practices

Texas contractors sometimes have unbalanced bids for the hot mix to disguise the true cost of hot mix (Table 28). These unbalanced bids will usually be reflected as a higher average price for hot mix and contribute to higher prices in Texas as compared to neighboring states.

Texas has separate bid items for aggregate and asphalt cement. If the contractor knows that the engineer has overestimated the quantity of asphalt cement required on the job, a bid will be submitted for asphalt at say 0.01 dollars per ton. The aggregate bid will cover all costs plus profit for hot mix. Thus it is often difficult to calculate a true in-place cost for asphalt concrete in Texas.

COST SAVING SUGGESTIONS

Several cost saving suggestions have been made by contractors during the conduct of this study. For convenience these suggestions will be organized under the following topics.

1. Production
2. Uncertainty
3. Transportation
4. Materials
5. Mixing and Mixing Plants
6. Laydown and Compaction

Production

A previous discussion has illustrated the importance of achieving high production (Figure 8). An increase of from 500 to 1000 tons per day can alter cost of hot mix 8 dollars per ton. Higher production can only be achieved by having cooperation from both the contractor and the inspector. The "old spirit" of "get the job done" and "build a good job" must be realized on the project to achieve high production. Inspector inexperience often hinders production.

Large jobs contribute to high production and low unit costs. Thick lift placement of hot mix also contributes to high production.

A closed "asphalt season" should be avoided. Any decision "to pave" should be established based on realistic cessation requirements.

Lane closures which will normally contribute to high production should be considered to achieve high production.

Uncertainty

Uncertainty associated with preparing bids for a project should be minimized. The delay between the letting and start and completion of construction should be as short as possible. Contractor advice to set working day requirements may be helpful. Prebid conferences are often useful if new techniques or materials are to be used on the job.

Uncertainty associated with labor availability, labor productivity, air quality and safety requirement, fuel prices, transportation costs and material prices and availability should be reduced if possible. Because of the rail car shortage, some contractors will prepare bids based on truck delivery of aggregate rather than rail delivery. This escalates prices (Table 25).

The establishment of a uniform year to year SDHPT demand for hot mix on both a state and regional basis will allow for cost reductions as illustrated previously. If demand could be evened out, savings of the order of 20 percent could be anticipated.

Escalation or price adjustment clauses should be considered for asphalt cement and perhaps transportation costs. The hot mix contractors are undecided on the asphalt cement price adjustment issue (50-50 split of preference).

Transportation

The state should consider the acceptance of larger haul units for dumping directly into the laydown machine. Savings of up to 3 cents per ton mile could be obtained.

Materials

Locally available materials should be used whenever possible in order to minimize both transportation costs and energy consumption. Mixture designs should be formulated on a state-contractor cooperative basis. Information on locally available aggregates should be supplied to contractors by the state prior to the letting.

Aggregate gradations satisfactory for use both as seal coat cover stone and coarse aggregate for hot mix should be investigated. Aggregate availability and hot mix letting should be coordinated.

Mixing and Mixing Plants

Mix temperatures should be reduced as low as possible while maintaining

the desired mixing and compaction qualities. For each 25°F decrease in mixing temperatures, a 5-cent saving per ton can be realized.

Fifty cents to 1.50 dollars per ton can be saved by using drum mixing plants. The hot screens should be considered for removal from batch plants provided acceptable cold feed control can be obtained. Selection of hot screen should be at the discretion of the contractor to achieve good bin balance (provided adequate quality control can be achieved).

Air quality and safety standards should be investigated to ascertain their component cost in hot mix operations. The time to obtain permits to operate a hot mix plant needs to be substantially reduced.

Laydown and Compaction

A delay from one to two hours can be experienced if overnight longitudinal joint exposure is not allowed. A 10 to 30 cent saving per ton can be achieved if overnight joint exposure is allowed.

Density control should be considered. Most contractors favor density control provided they can select the type and roller pattern.

FHWA Cost Saving Suggestions

Federal Highway Administration cost saving suggestion are given below (15):

1. Liberal policies which will encourage quick progress payments to contractors and pay for materials stockpiled both on and off construction sites, thus reducing contractors' needs to borrow
2. Policies for granting more realistic time extensions when temporary material shortages occur at no fault of the contractor

3. Contract incentive clauses where appropriate to take advantage of contractor initiative and innovations to reduce costs
4. Mechanisms to encourage states to incorporate voluntary wage-price guidelines into their highway construction programs in further support of the President's anti-inflation efforts
5. Limits to size and duration of contracts where possible to allow completion of a project within one construction season by "staging" or "phasing" large projects or by letting smaller projects
6. Provisions for increasing the use of alternate designs to provide more flexibility to contractors and ensure the lowest cost method is used for construction
7. Scheduling of advertising periods and project lettings so as to attract the most competition available

These suggestions should be considered by the Texas SDHPT.

FUTURE PRICE OF ASPHALT CONCRETE

Based on data obtained in 1979, Texas contractors expected asphalt concrete to escalate 8 to 15 percent per year in the short term (next two to three years). Long range estimates were not provided by the contractors. In the opinion of the authors, a short term increase of 20 percent should be expected in Texas in (1980,1981). An average of 10 percent per year should be expected over the next 5 to 10 years. Table 29 shows cost possibilities with various inflation rates.

Price projections for asphalt cement are of interest as the price of asphalt concrete is controlled to a significant extent by its price. Figure 10

shows asphalt cement price projections to 1982. Average 1980 prices are expected to be 150 dollars per ton while 1982 prices may exceed 200 dollars per ton (16). An approximate indicator of future asphalt cement price (dollars per ton) can be obtained by multiplying the average refinery acquisition cost of crude oil (dollars per barrel) by 6.0 (9). The cost escalation of Mideastern crude oil is shown on Figure 11 (16,17). It is not unrealistic to project 170 dollars per ton asphalt cement in 1980 and 250 dollars per ton asphalt cement in 1982.

Projections for aggregate costs have not been made but are of great importance to the future price of asphalt concrete. It is, however, anticipated that the cost of aggregates in Texas will be in excess of the average inflation rate of construction items in Texas.

CONCLUSIONS

1. The cost escalation of asphalt concrete is not unlike that experienced by many types of construction materials (Tables 2 and 3).
2. The price increase for asphalt concrete in Texas can be largely explained by increased material, energy and transportation costs (Table 26).
3. Asphalt concrete cost savings can be obtained by performing the following:
    a. Increase daily job production
    b. Reduce contractor cost uncertainties
    c. Reduce the time delay between letting and start and completion of construction
    d. Provide better rail transportation
    e. Use locally available aggregates

4. Implementation of these cost saving suggestions should reduce costs by an average of about 2 dollars per ton thereby resulting in an annual savings of about 9,000,000 dollars ($2 per ton x 4.5 million tons).
5. The price of asphalt concrete is expected to increase at an annual rate of 20 percent for the next two years.

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Table 1. Average Price Increases for Asphalt Concrete.*

	United States		Region 6		Texas		Oklahoma		Louisiana	
Year	Price	Index	Price	Index	Price	Index	Price	Index	Price	Index
1967 **	6.47	100.0	6.26	100.0	6.40	100.0	5.04	100.0	8.52	100.0
1968	6.77	104.6	6.67	106.5	6.43	100.5	6.17	122.5	8.07	94.7
1969	7.11	109.9	7.11	113.2	7.20	112.4	6.10	121.2	8.78	103.0
1970	8.04	124.3	7.31	117.0	7.35	114.7	6.44	127.9	9.74	114.3
1971	8.54	132.1	8.37	131.6	8.61	134.4	7.01	139.2	9.37	109.9
1972	9.22	141.1	8.99	149.3	10.49	163.8	7.01	139.2	7.52	88.3
1973	9.99	154.5	10.46	178.7	12.32	192.3	7.88	156.5	14.23	167.09
1974	14.74	228.0	15.40	259.7	18.94	295.8	10.91	216.7	17.73	208.1
1975	15.13	233.8	17.03	311.7	23.64	369.2	14.58	289.7	21.95	257.6
1976	14.83	229.4	16.96	297.1	22.15	345.9	13.75	273.2	21.06	247.2
1977	15.47	239.1	17.30	311.5	22.76	355.3	15.46	307.2	18.01	211.4
1978	17.16	265.4	20.25	373.2	27.30	426.3	19.97	396.7	21.44	251.7
1979	21.21	327.8								

*Dollars Per Ton In Place

**1976 Base Year

After Reference 1

Table 2. Average Annual Increase in Consumer Goods and Selected Construction Prices.

Item	Average Annual Increase in Prices, Percent	
	1973 to 1979	1968 to 1979
Consumer Price Index	8.0	6.5
Highway Bid Price Index - U.S.	11.7	9.9
Highway Bid Price Index - Texas	14.9	13.5
Asphalt Concrete - U.S.	11.5	9.7
Asphalt Concrete - Region 6	14.1	11.7
Asphalt Concrete - Texas	17.2	15.6
Asphalt Concrete - Oklahoma	20.4	12.5
Asphalt Concrete - Louisiana	8.5	10.2

Table 3. Typical United States Average Annual Price Increase for Selected Construction Items - 1973 to 1979.

Item	Unit	Average Price		Average Annual Increase in Price, Percent
		1973	1979	
Composite Index		152.4	264.9	11.7
Common Excavation	cy	0.80	1.54	14.0
PCC Surfacing	sy	6.87	11.49	10.9
Asphalt Concrete	ton	9.99	17.16	11.5
Reinforcing Steel	lb	.207	.316	8.8
Structural Steel	lb	.372	.603	10.2
Structural Concrete	cy	111.83	172.41	9.0

Table 4. Typical Average Annual Price Increases for Selected Consumer Goods and Services - 1973 to 1978.

Commodity or Index	Average Annual Increase in Price Percent	1978 Increase Percent
Consumer Price Index	8.0	9.0
Electricity	10.4	8.0
Gas for the home	15.6	10.5
All Foods	8.4	10.0
Meat	5.1	18.7
New Car	6.8	7.6
Medical Care	9.1	8.4
Physician's Fees	10.1	8.3
Renting a Home	5.6	6.8
Appliances	4.2	3.7
Property Taxes	4.9	6.3
Clothing	4.1	2.6
Natural Gas - Texas*	45.0	*
Oranges		57.6
Apples		21.1
Hamburgers		34.8
Hot Dogs		28.8
Beer		8.0
Soft Drinks		7.7
Whole Milk		8.0
Women's Dresses		5.8
TV Sets		0.6

*1973 to 1977, Texas Energy Advisory Council.
After Reference 2.

Table 5. Posted Price of Asphalt Concrete in Major Metropolitan Area*.

Date	Type "D"		1 1/2 inch Black Base		City Type F	
	Price, dollars per ton	Price Index	Price, dollars per ton	Price Index	Price, dollars per ton	Price Index
September 1972	6.50	100	6.00	100	7.00	100
February 1973	6.75	104	6.25	104	7.50	107
October 1973	7.50	115	7.00	117	8.50	121
April 1974	9.25	142	8.75	146	10.00	143
July 1974	10.00	154	9.25	154	11.00	157
November 1974	11.00	169	10.25	171	12.00	171
May 1975	12.00	185	10.50	175	13.25	189
March 1976	12.00	185	11.25	188	13.50	193
June 1977	13.50	208	13.50	225	14.25	204
October 1977	13.75	212	13.50	225	14.25	204
February 1978	13.85	213	13.50	225	14.25	204
March 1978	14.25	219	14.00	233	14.50	207
April 1978	14.50	223	14.25	238	15.00	214
June 1978	15.00	231	14.75	246	15.50	221
October 1978	15.50	238	15.25	254	16.00	229
January 1979	16.75	258				
September 1979	20.00	308	19.25	321	21.00	300

*FOB plant price for producer E.

Table 6. Typical Asphalt Price Escalation*.

Date	Price, dollars per ton	Price Index
1969	6.75	
July 1973	8.75	100
January 1974	9.75	111
July 1974	11.50	131
November 1974	12.00	137
March 1975	13.00	149
June 1977	13.50	154
February 1978	14.50	166
December 1978	15.50	177
September 1979	17.50	200

*FOB plant price for producer F.

Table 7. Typical Asphalt Concrete Price Escalation*.

Date	Plant 1		Plant 2	
	Price, dollars per ton	Price Index	Price, dollars per ton	Price Index
March 1974	7.50	100		
September 1974	9.00	120		
November 1975			10.50	100
September 1976	9.50	127	11.00	105
May 1977			12.00	114
November 1977	10.00	133		
May 1978	11.00	147	13.50	129
February 1979	12.00	160	15.00	143
September 1979	13.50	180	16.00	152

*FOB plant price for producer 0.

Table 8. Typical Asphalt Concrete Price Escalation.

Year	Producer D		Producer H		Producer V					
					Plant 1		Plant 2		Plant 3	
	Price*	Price Index	Price*	Price Index	Price**	Price Index	Price**	Price Index	Price**	Price Index
1972					4.58	90	5.10	101		
1973			20.00	100	5.07	100	5.05	100	4.49	100
1974	10.27	100	23.00	112	6.84	135	6.79	134	7.65	170
1975	16.03	156	25.50	124	7.56	149	9.00	178	8.26	184
1976	15.30	149	28.50	139	9.34	184	9.03	179	8.27	184
1977	19.43	189	31.50	154	10.35	204	10.40	206	10.24	228
1978	19.81	193	35.00	170	12.18	240	10.74	213	11.36	253
1979***					14.25	281	13.00	257	14.05	313

*Dollars per ton in-place.

**Average selling price, dollars per ton FOB plant.

***Posted FOB plant price, dollars per ton.

Table 9. Market Distribution of Hot Mix Asphalt Concrete in the United States and Texas.

Year	Percent of Total Production	
	New Construction	Reconstruction
1965	62	38
1966	62	38
1967	56	44
1968	58	42
1970	51	49
1971	54	46
1972	55	45
1973	53	47
1974	54	46
1975	47	53
1976	46	54
1975 (Texas only)	62	38
1976 (Texas only)	69	31

After References 3 and 4.

Table 10. Percent Distribution of Hot Mix Asphalt Concrete Production in the United States and Texas (1975 and 1976).

Market	U.S.		Texas	
	1975	1976	1975	1976
Interstate Highways	13	10	27	19
State Highways	32	34	15	12
Municipal & County Roads	24	24	12	21
Airports	3	2	7	3
Private and Commercial	26	27	38	43
Other	2	3	1	2

After Reference 3.

Table 11. Market Split for Producer P - Tons Per Year.

Year	SDHPT	City & County	Private or Commercial	Airport	Total
1970	108,672	70,290	53,401	0	232,363
1971	232,980	65,000	51,309	0	349,289
1972	150,000	82,556	75,000	0	307,555
1973	24,698	58,521	95,000	66,286	244,505
1974	128,645	62,781	115,000	10,000	316,426
1975	129,000	35,000	69,505	4,000	237,505
1976	10,000	45,000	103,885	10,000	158,885
1977	100,000			0	204,390
1978	126,000	78,750	110,250	0	315,000

*Texas State Department of Highways and Public Transportation.

Table 12. Percent Component Costs for Asphalt Concrete Production - 1978.

Cost	Producer											
	B	C	D	E	F	H	I	M	O	P	Q	Average
Asphalt Cement	37.8	39.4	27.9	24.5	26.3	18.1	24.6	24.5	31.4	26.8	30.6	28.4
Aggregate	37.9	35.3	38.2	44.9	37.5	47.9	32.8	51.4	35.5	40.9	42.4	40.4
Energy Costs	5.7	6.8	4.7	6.5	4.0	3.1	7.6	4.4	6.7	4.4	4.2	5.3
Mixing**	11.4	15.0	12.4	12.3	17.9	13.9	18.6	10.1	10.1	16.0	11.4	13.6
Miscellaneous Item***	2.4	0.7	1.8	0	1.5	5.2	2.0	0.5	3.3	2.8	2.3	2.0
Mark-Up	4.8	2.8	15.0	11.8	12.8	11.8	14.4	9.1	13.0	9.1	9.1	10.3
FOB Plant Price	12.27	10.36	16.34	15.50	15.58	22,80	14.33	20.00	14.97	16.00	13.20	

* Includes heating, drying & other energy costs.

** Includes depreciation on all plant equipment.

*** Taxes, insurance dues, bonds, office, etc.

Table 13. Percent Component Cost for Asphalt Concrete In-Place.

Cost Component	Producer						
	B	D	H	I	M	P	Average
Asphalt Cement	28.9	22.9	15.3	17.9	20.1	19.3	20.7
Aggregate	29.0	31.6	40.7	23.9	42.1	29.2	32.9
Energy Costs*	4.4	3.9	2.7	5.5	3.6	3.1	3.9
Mixing**	8.7	10.3	11.8	13.6	8.3	11.4	10.7
Haul, Laydown & Compaction	22.1	14.8	13.3	22.1	16.4	19.4	18.0
Miscellaneous Items***	1.9	1.5	4.4	2.0	.4	2.0	2.0
Mark-Up	5.0	15.0	11.8	14.5	9.1	15.6	11.8
In-Place Price	16.03	19.80	33.90	23.42	24.41	22.39	

* Includes heating, drying and other energy costs.

** Includes depreciation on all plant equipment.

*** Taxes, insurance, dues, bonds, office, etc.

Table 14. Percent Component Cost for Asphalt Concrete In-Place.

Cost Component	Percent of In-Place Cost		
	After Layman (6)	After Foster (7)	After Barber-Greene (8)
Asphalt Cement	43.3	19.0	31.0
Aggregate		29.6	20.6
Energy	2.1	5.3	12.5
Mixing	16.2		
Haul, Laydown & Compaction	22.2	37.1	12.9
Miscellaneous Items	1.2		23.0
Mark-Up	15.0*	9.0	

*Assumed.

Table 15. Average Yearly Production Costs Per Ton - Producer C.

Year	Labor	Drier Fuel	Electric Utilities	Repairs	Asphalt Cement	Aggregate	Ownership	Miscellaneous Expenses	Total Cost	Selling Price	Profit
1974	0.46 (5.6)*	0.47 (5.7)	0.10 (1.2)	0.08 (1.0)	3.13 (38.2)	2.47 (30.1)	0.87 (10.6)	0.62 (7.6)	8.20 (100)	8.29	+1.1
1975	0.54 (5.6)	0.76 (7.9)	0.16 (1.7)	0.19 (2.0)	3.71 (38.6)	2.97 (30.9)	0.88 (9.2)	0.40 (4.1)	9.61 (100)	9.44	-1.8
1976	0.40 (4.5)	0.53 (5.9)	0.17 (1.9)	0.17 (1.9)	3.71 (41.6)	2.90 (32.5)	0.85 (9.5)	0.19 (2.2)	8.92 (100)	9.56	+7.2
1977	0.43 (4.5)	0.48 (5.1)	0.17 (1.8)	0.19 (2.0)	3.91 (41.3)	3.42 (36.1)	0.61 (6.4)	0.26 (2.8)	9.47 (100)	9.59	+1.3
1978	0.59 (5.9)	0.54 (5.4)	0.17 (1.7)	0.35 (3.5)	4.08 40.5)	3.66 (36.3)	0.61 (6.1)	0.07 (0.6)	10.07 (100)	10.36	+2.9

*Percent of total cost.

Table 16. Individual Cost Component Increases for 1974 to 1978 - Producer C.

Item	Price Index
FOB plant cost	123
Asphalt cement	130
Aggregate	148
Labor	128
Drier fuel	115
Electric utilities	170
Repairs	438
Ownership	70
Miscellaneous expenses	11

Table 17. Posted Price of AC-10/20 Asphalt Cement at a Houston Area Refinery.

Date	Price, Dollar Per Ton	Price Index*
August 1966	16.45	44
August 1970	17.63	47
November 1970	18.80	50
January 1971	21.15	56
July 1971	23.50	63
November 1973	37.60	100
February 1974	48.88	130
March 1974	54.05	144
October 1974	58.16	155
February 1975	59.33	158
June 1975	64.04	170
February 1977	66.39	177
January 1978	70.50	188
January 1979	74.97	199
April 1979	82.00	218
August 1979	95.00	253
January 1980	131.00	348

*1973 Base year.

Table 18. AC-20 Asphalt Cement Price FOB City Indicated - March 6, 1980*.

City	Price, Dollars Per Ton	Relative Price Index**
Atlanta	130	98
Baltimore	143	108
Boston	145	110
Chicago	140	106
Cincinnati	96	73
Cleveland	140	106
Dallas	135.90	103
Denver	126	95
Detroit	143.60	109
Houston	132.00	100
Kansas City	135.00	102
Los Angeles	150.00	114
Minneapolis	140.00	106
New York	104.00	79
Philadelphia	105.00	80
Pittsburgh	147.00	111
St. Louis	125.00	95
San Francisco	133.00	101
Seattle	116.00	88
Montreal	103.44	78
Toronto	138	105

*After Reference 19.

**Based on Houston price.

Table 19. Relative Cost of Asphalt Materials in the Texas Gulf Coast Area.

Material	Price*		
	Dollars Per Gallon	Dollars Per Ton	Relative Price**
AC-3	.561	132.00	100
AC-5	.561	132.00	100
AC-10	.561	131.00	100
AC-20	.561	131.00	100
RC-70	.75	188.30	133
RC-250	.75	187.10	133
RC-800	.75	184.20	133
RC-3000	.75	182.25	133
MC-30	.63	158.60	112
MC-70	.63	159.40	112
MC-250	.63	153.50	112
MC-800	.63	156.10	112
MC-3000	.63	154.60	112
EA-HVRS	.63	146.20	112
EA-HVRS-90	.63	146.20	112
EA-HVMS	.64	148.50	114
EA-11M	.64	148.50	114
CRS-2	.63	146.20	112

Note: SC materials have a relative price of about 108 at refineries in the North Central U. S.

*FOB source of production.

**Relative to AC-10 on a volume of binder basis.

Table 20. Price of Gasoline.

Date	Price Per Gallon, Cents
October, 1973	40.2
March, 1974	52.8
August, 1976	60.3
March, 1979	71.0
July, 1979	100.0*
March, 1980	125.0*

*Estimated.

After Reference 10.

Table 21. Typical Aggregate Price Escalation*.

Date	Type "D" Aggregate		Aggregate Concrete Sand		Washed Concrete Sand	
	Price, Dollars Per Ton	Price Index	Price, Dollars Per Ton	Price Index	Price, Dollars Per Ton	Price Index
Feb-71	1.70	100	1.05	100	0.55	100
July-72	1.20	71				
Jan-74	1.65	97	1.25	119	0.75	150
April-74	1.95	114	1.25	119	0.75	150
July-74	2.10	124				
Jan-75	2.55	150	1.20	114		
Oct-75	2.95	174	1.95	186	1.45	290
Dec-76	3.20	188	2.20	210	1.70	340
Aug-77	3.50	206	2.50	238	2.00	400
Oct-77	4.20	247	2.50	238	2.00	400
Oct-78	4.60	270	2.55	243	2.20	440
Sept-79	5.05	297	2.80	267	2.40	480

*FOB aggregate production source - central Texas.

Table 22. Typical Crushed Stone Price Escalation - Producer V.

Year	Plant 1		Plant 2		Plant 3	
	Price*	Price Index	Price*	Price Index	Price*	Price Index
1972	1.92	100	2.00	77		
1973	1.92	100	2.61	100		
1974	2.17	113	3.24**	124		
1975	2.29	119	2.51	96**	2.75**	100
1976	2.24	117	2.41	92**	3.46**	126
1977	2.19	114	3.61	138	1.92	70
1978	2.56	133	4.48**	172	4.29	156
1979***	3.60	188	4.50	172		

*FOB plant price.

**Small quantities.

***FOB plant posted price.

Table 23. Cost of Fuel to Heat Aggregate for One Ton of Asphalt Concrete - Producer F.

Year	Cost to Heat Aggregate, Dollars	Fuel
1970	0.15	Natural Gas
1971	0.16	Natural Gas
1972	0.17	Natural Gas
1973	0.21	Natural Gas
1974	0.34	Natural Gas
1975	0.50	Natural Gas
1976	1.00	Natural Gas
1977	----	Fuel Oil
1979	0.75-0.85	Fuel Oil
1980	1.00 +	Fuel Oil

Table 24. Average Yearly Costs for Laydown Operation Per Ton of Asphalt Concrete - Producer C.

Unit	Cost	Comment
Labor	1.89	Can be as low as 0.40 on large jobs
Equipment	1.23	Ownership cost, rental costs, operating, costs
Tack or Prime Coat	0.75	Materials, labor and equipment
Supplies	0.22	Miscellaneous small equipment and expendable supplies, vehicle fuel, oil, fillers
Overhead	0.73	Mobilization, traffic control, supervision, office
Total	4.82	

Note: Trucking costs not included.

Table 25. Aggregate Transportation Costs into Houston Area - January 1979 - Producer E.

Type of Material	Transportation Cost, Dollars Per Ton		Cost of Aggregate at Plant, Dollars Per Ton*
	Rail	Truck	
Type "D" Limestone Central Texas	4.60	8.63	7.94
Limestone Screenings Central Texas	4.60	8.63	6.82
Type "F" Limestone Central Texas	4.60	8.63	7.94
Black Base Gravel Eagle Lake	5.20	2.60	7.00
Pea Gravel Eagle Lake	5.20	2.60	6.75
Field Sand		1.50	3.50
Iron Ore Montgomery County		1.50	6.75

*Assumes rail delivery except for field sand and iron ore.

Table 26. Summary of Cost Component Study of Asphalt Concrete - 1973 to 1978.

Cost Component	Component Cost, Percent (See Table 13)	Average Annual Price Increase, Percent 1973 - 1978*	Fraction of Average Annual Price Increase**	Percentage of Total Price Index Increase
Asphalt Cement	20.7	13.5	2.8	20.4
Aggregate	32.9	20.0	6.6	48.2
Energy Costs	3.9	30.0	1.2	8.8
Mixing	10.7	10.0	1.1	8.0
Haul Laydown & Compaction	18.0	10.0	1.8	13.1
Miscellaneous Items	2.0	8.0	.2	1.5
Mark-Up	11.8	0	0	0
		Weighted Increase in Average Annual Price Increase 1973 - 1978 →	13.7	100.0

*Obtained from estimates based on data collected in this study.

**Product of component cost and average annual price increase.

Table 27. Tons of Asphalt Cement Shipped.

	Texas*			U.S.**		
Year	AC-10	AC-20	AC-10 & AC-20	Asphalt Cements	Paving Products	Ratio of Texas to U.S. Percent
67-68	198,000	199,000	397,000			
68-69	215,000	292,000	507,000			
69-70	252,000	267,000	519,000			
70-71	269,000	329,000	598,000			
71-72	210,000	301,000	511,000			
72-73	220,000	269,000	489,000	27,370,000	27,040,000	1.8
73-74	255,000	288,000	543,000	25,149,000	24,642,000	2.2
74-75	313,000	288,000	601,000	22,113,000	21,593,000	2.7
75-76	154,000	170,000	324,000	21,926,000	21,617,000	1.5
76-77	192,000	137,000	329,000	25,299,000	23,010,000	1.3
77-78	262,000	242,000	504,000	29,485,000	26,172,000	1.7

*Tons for both contract and maintenance uses (240 gallons per ton). (September 1 to August 31)
**For the last year indicated (calendar year).
After Reference 13.

Table 28. Typical Unbalanced Bids.

Item	Contractor Cost + Mark-Up, $ Per Ton	Contractor Bid, $ Per Ton	Quantity, Tons
292 - Black Base	18.68	21.67	3,000
340 - Non-Polish	23.09	27.13	21,000
340 - Polish Resistant Aggregate	27.13	30.53	4,000

Table 29. Future Cost of Asphalt Concrete*.

	Inflation Rate, Percent					
Year	6	8	10	12	15	20
1979	25.00	25.00	25.00	25.00	25.00	25.00
1980	26.50	27.00	27.50	28.00	28.75	30.00
1985	35.46	39.67	44.29	49.35	57.83	74.65
1990	47.46	58.29	71.33	89.96	116.31	185.75
2000	84.99	125.85	185.01	270.10	470.54	1150.13

*Costs expressed in dollars per ton, a base of 25 dollars per ton was selected for 1979.

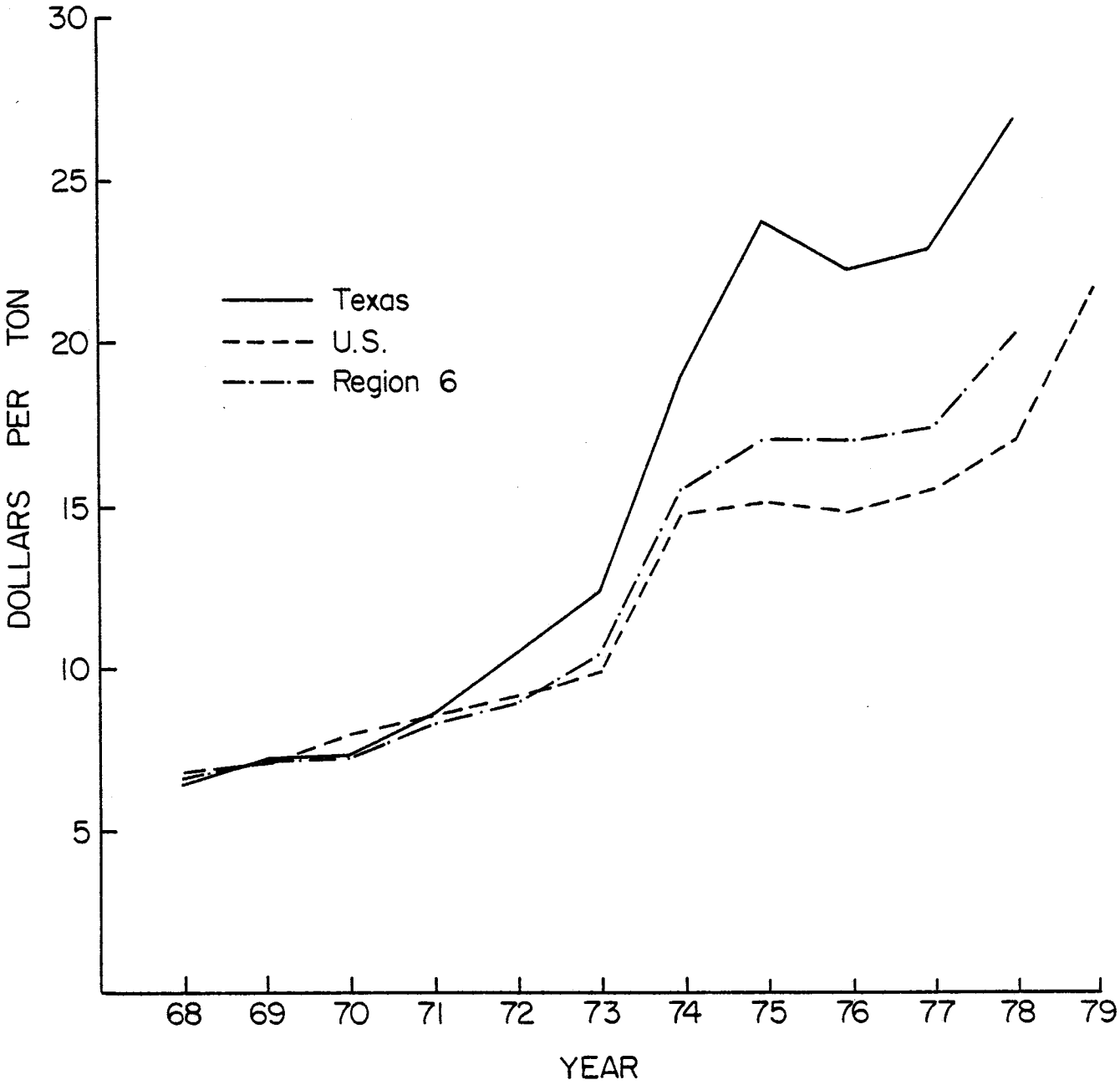


FIGURE 1. AVERAGE ANNUAL CONTRACT PRICE FOR BITUMINOUS CONCRETE

After reference 1

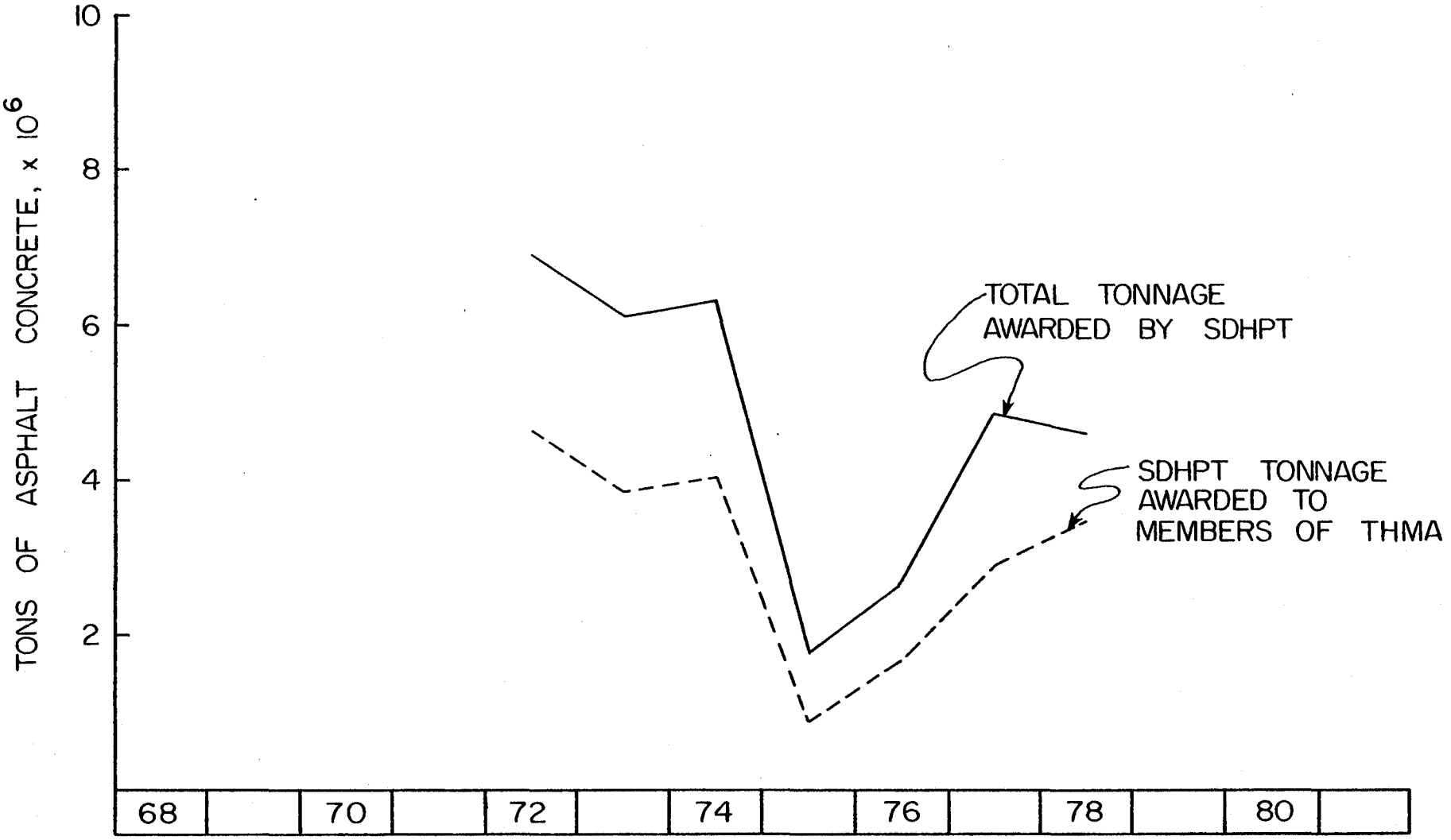


FIGURE 2. TONNAGE OF ASPHALT CONCRETE AWARDED BY TEXAS SDHPT

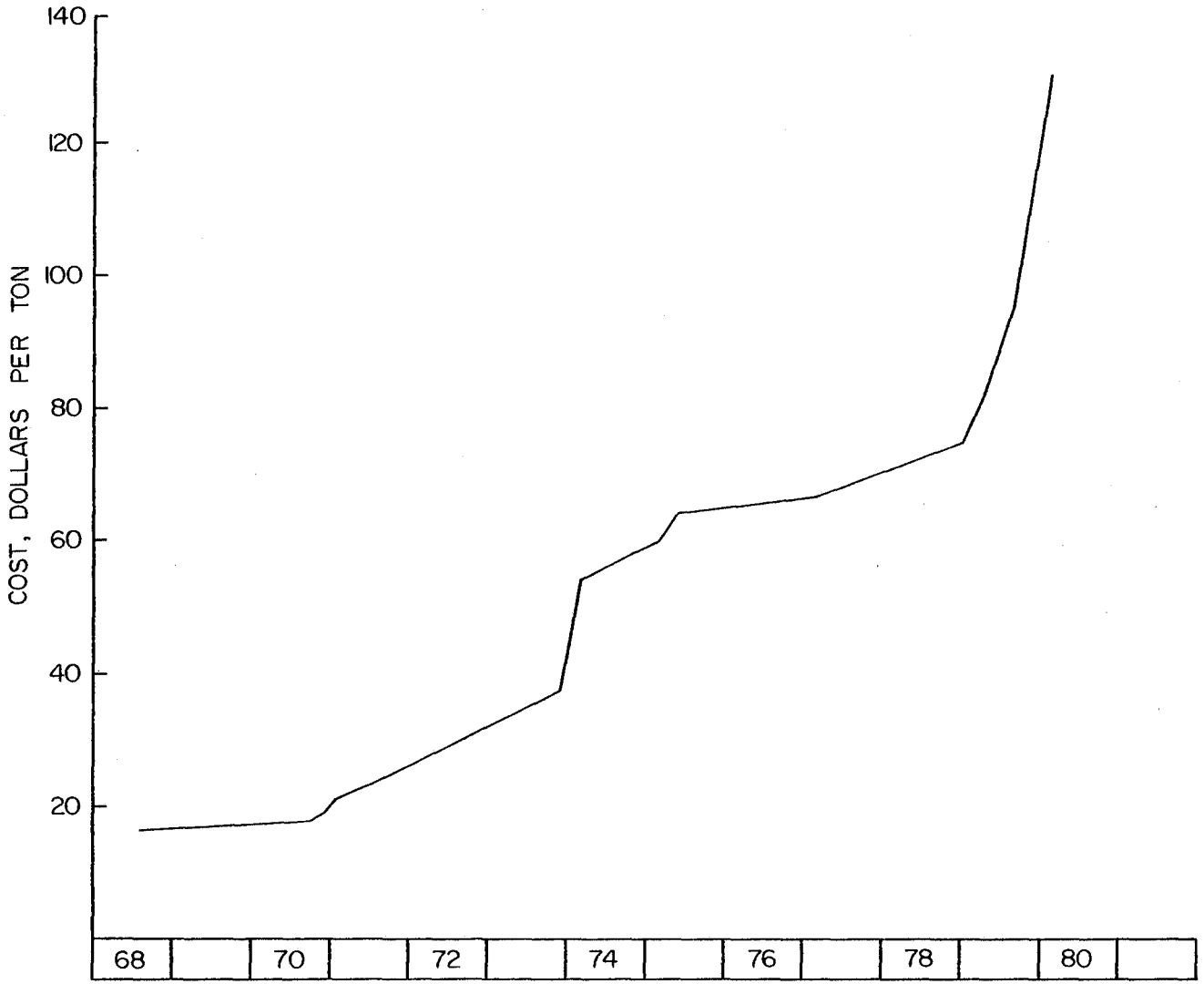


FIGURE 3. POSTED PRICE OF AC-10/20 ASPHALT CEMENT - TEXAS

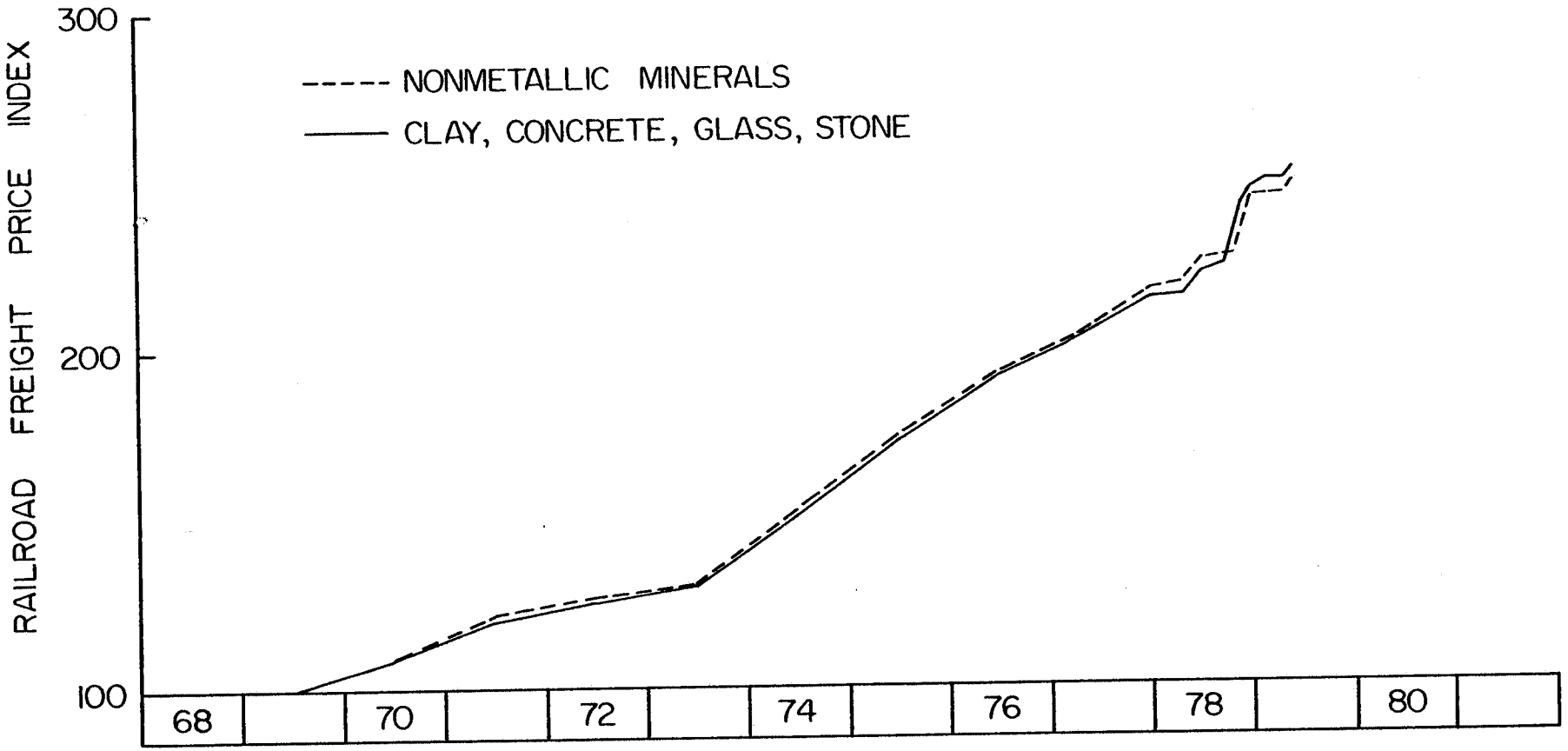


FIGURE 4. UNITED STATES PRICE INDEX FOR RAILROAD FREIGHT

After reference 10 and 11

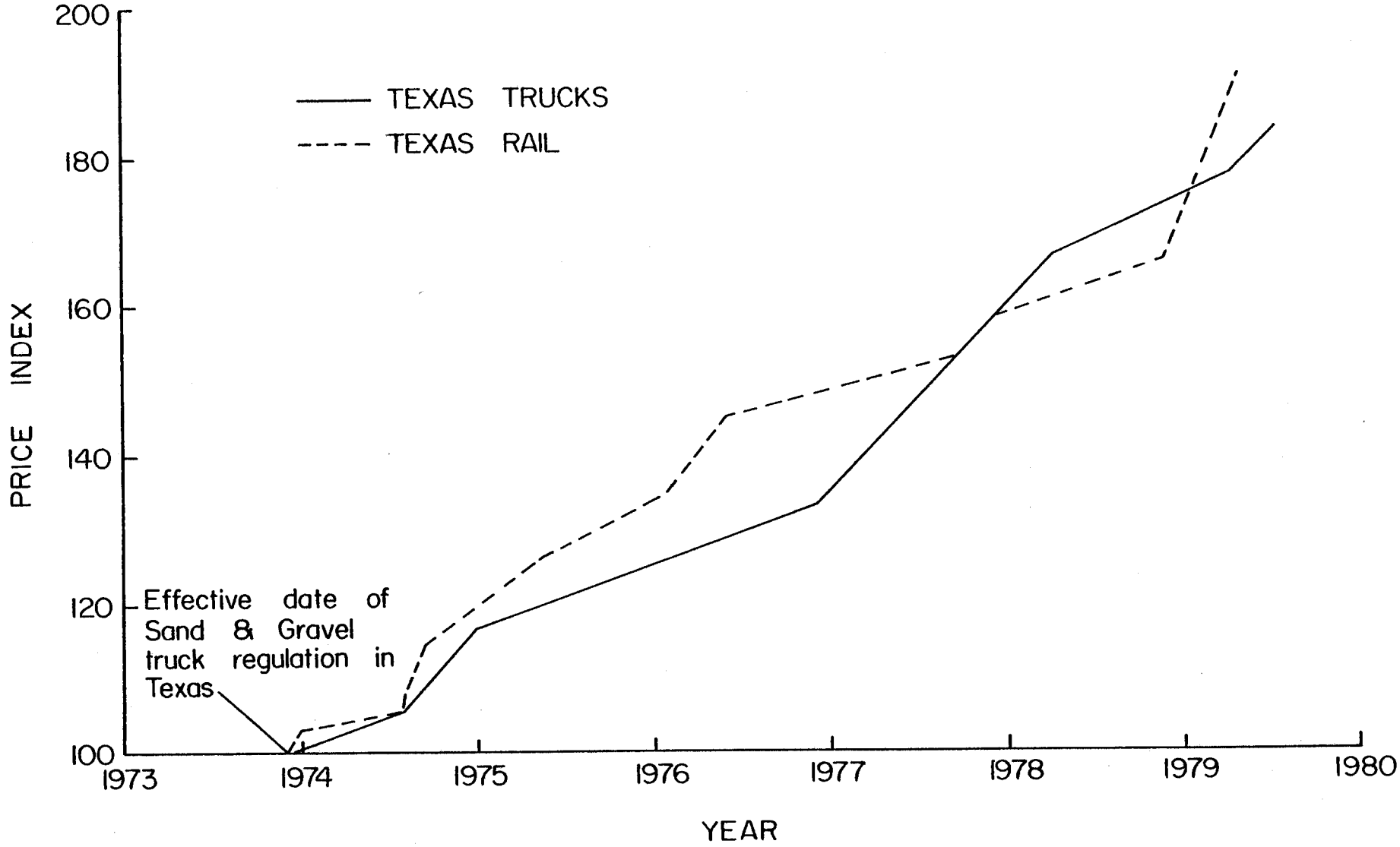


FIGURE 5. TEXAS INTRASTATE TRUCK AND RAIL TRANSPORTATION INDEX

After reference 12

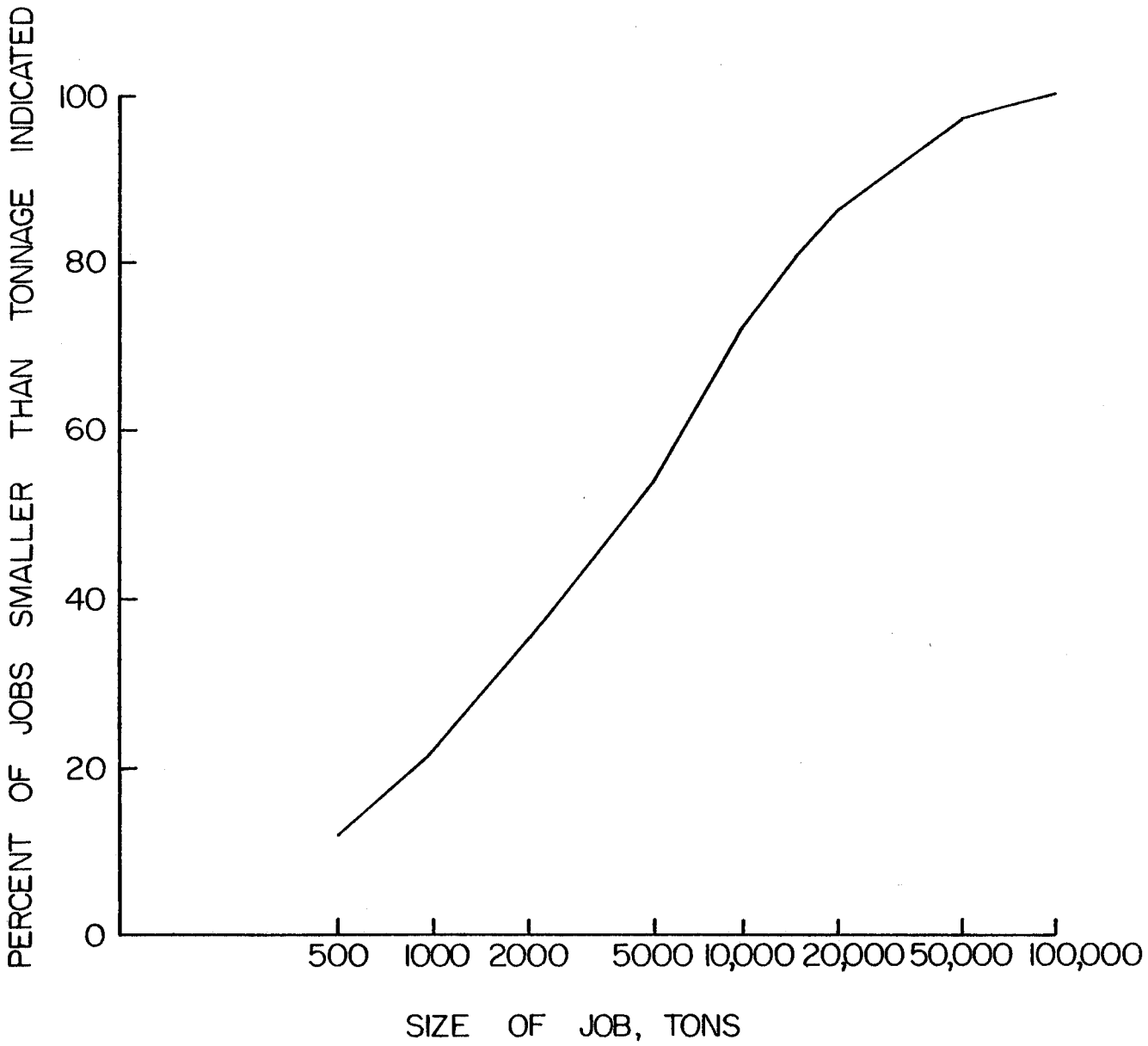


FIGURE 6. DISTRIBUTION OF SIZE OF TEXAS SDHPT JOBS AWARDED IN 1978

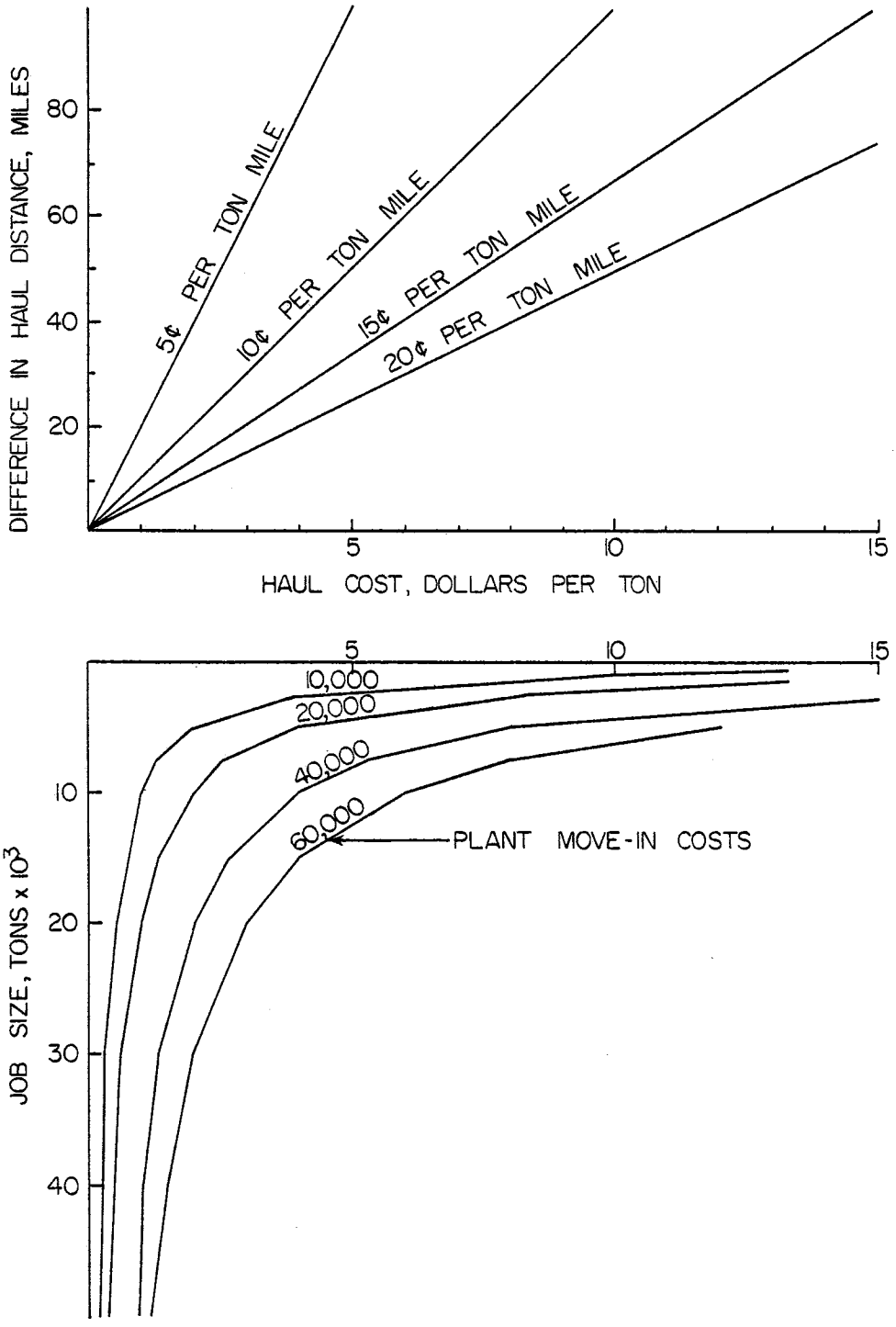


FIGURE 7. RELATIONSHIP BETWEEN HAUL COSTS AND PLANT MOVE-IN COSTS

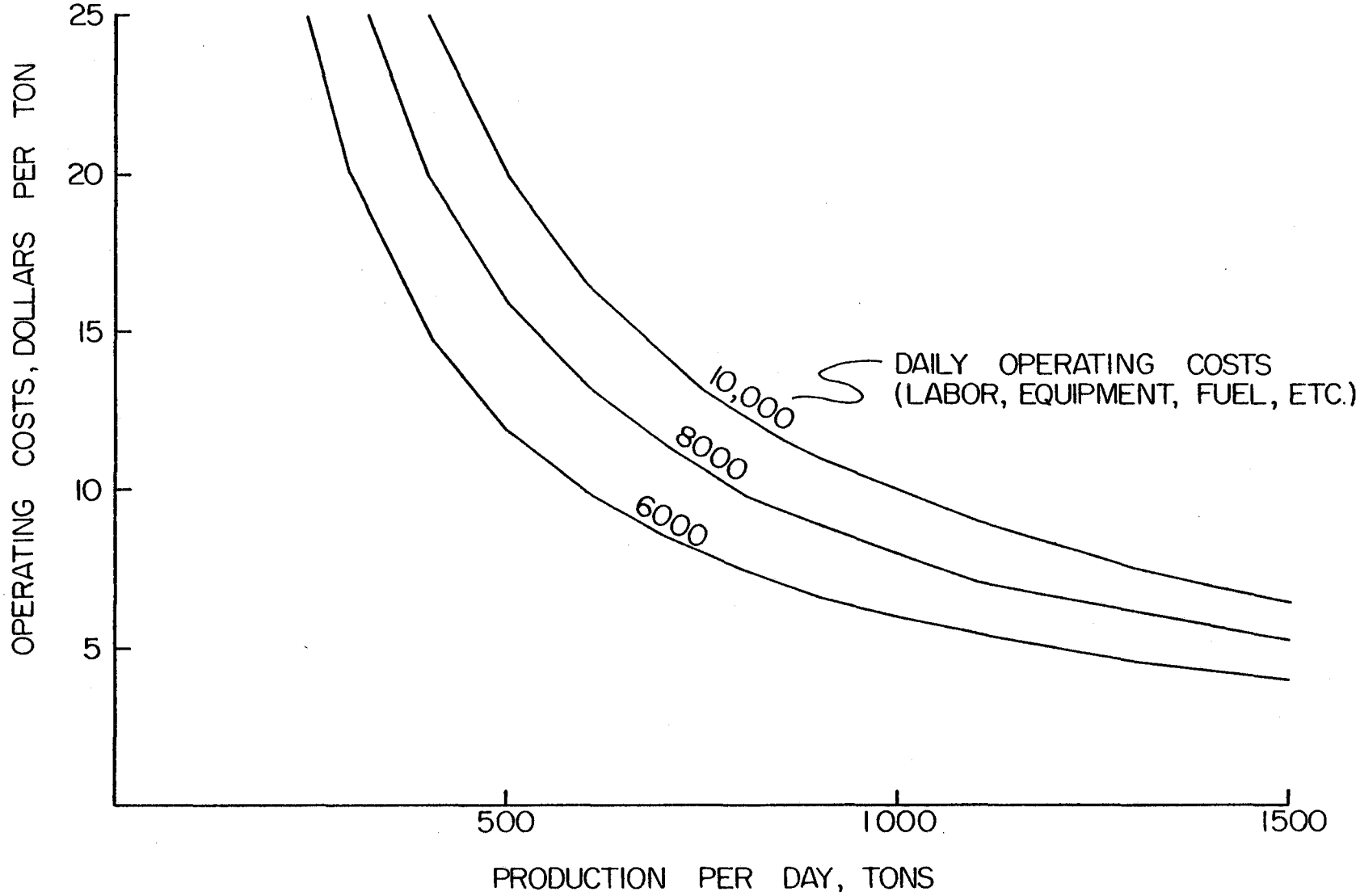


FIGURE 8. EFFECT OF PRODUCTION ON COST OF ASPHALT CONCRETE

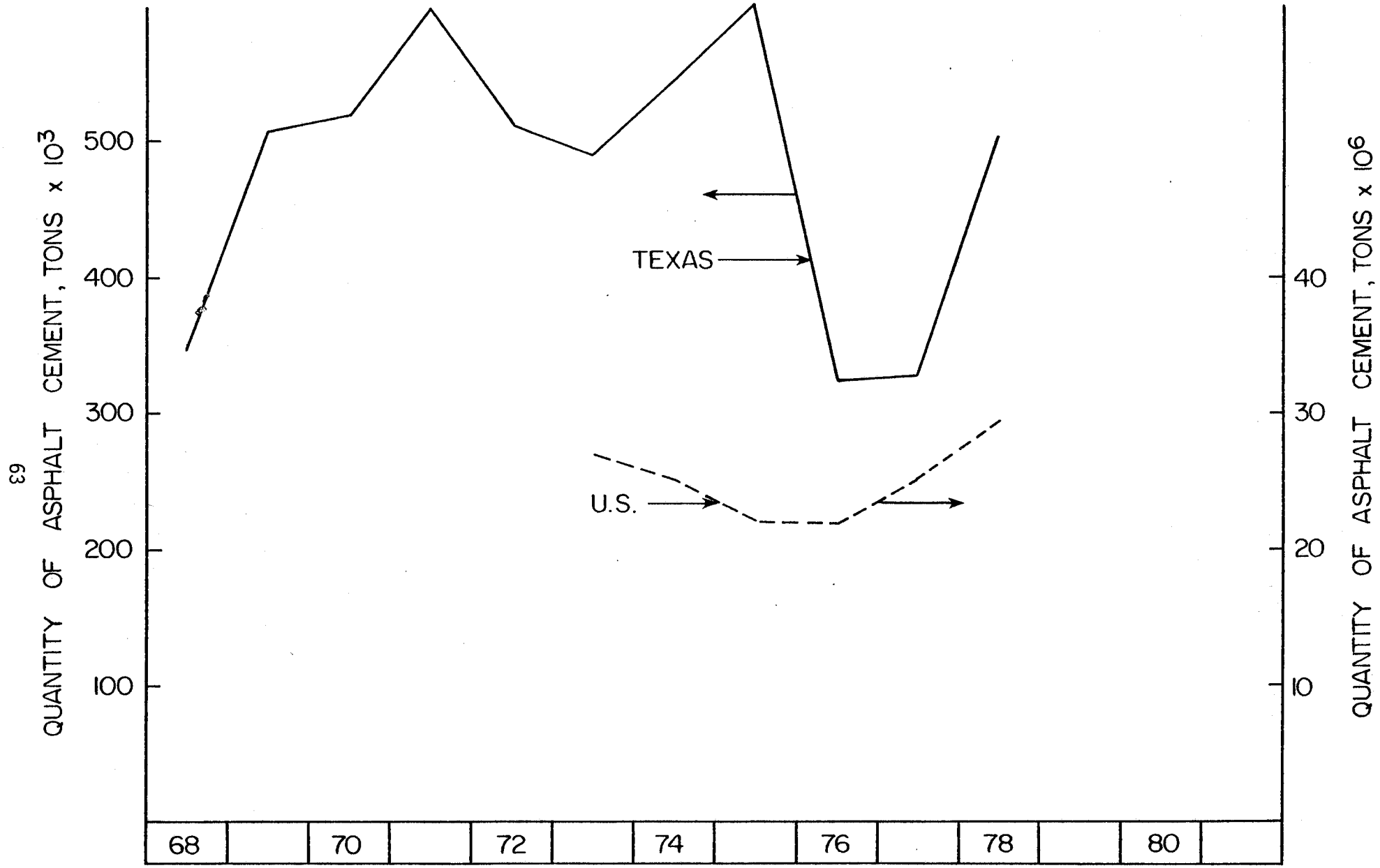
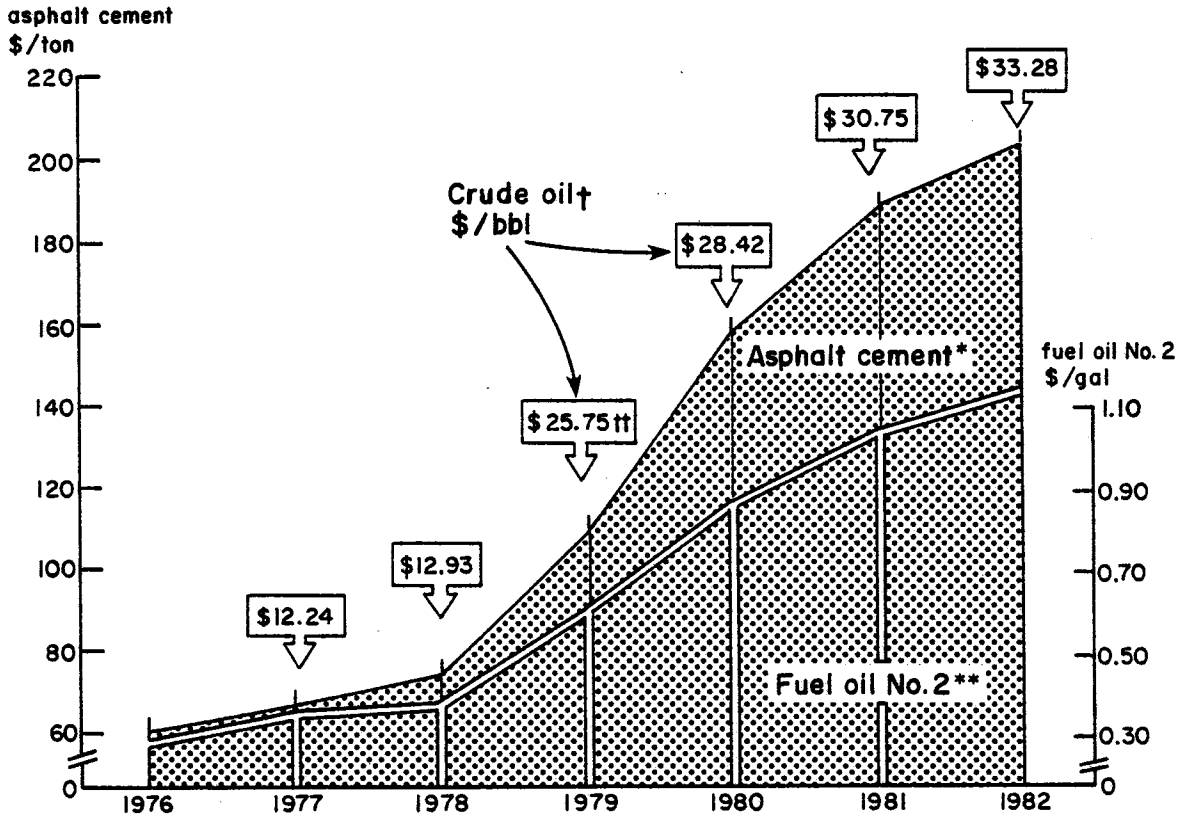


FIGURE 9. QUANTITY OF ASPHALT CONCRETE USED IN UNITED STATES AND TEXAS

After reference 13



*Source: National Asphalt Pavement Association, Engineering News-Record, Department of Energy. *ENR's 20-city average price **average refiner's selling price (DOE) †composite refiner aquisition cost (DOE). ††NAPA estimate*

FIGURE 10. ASPHALT CEMENT PRICE FORECAST: 1980-82.

After reference 16

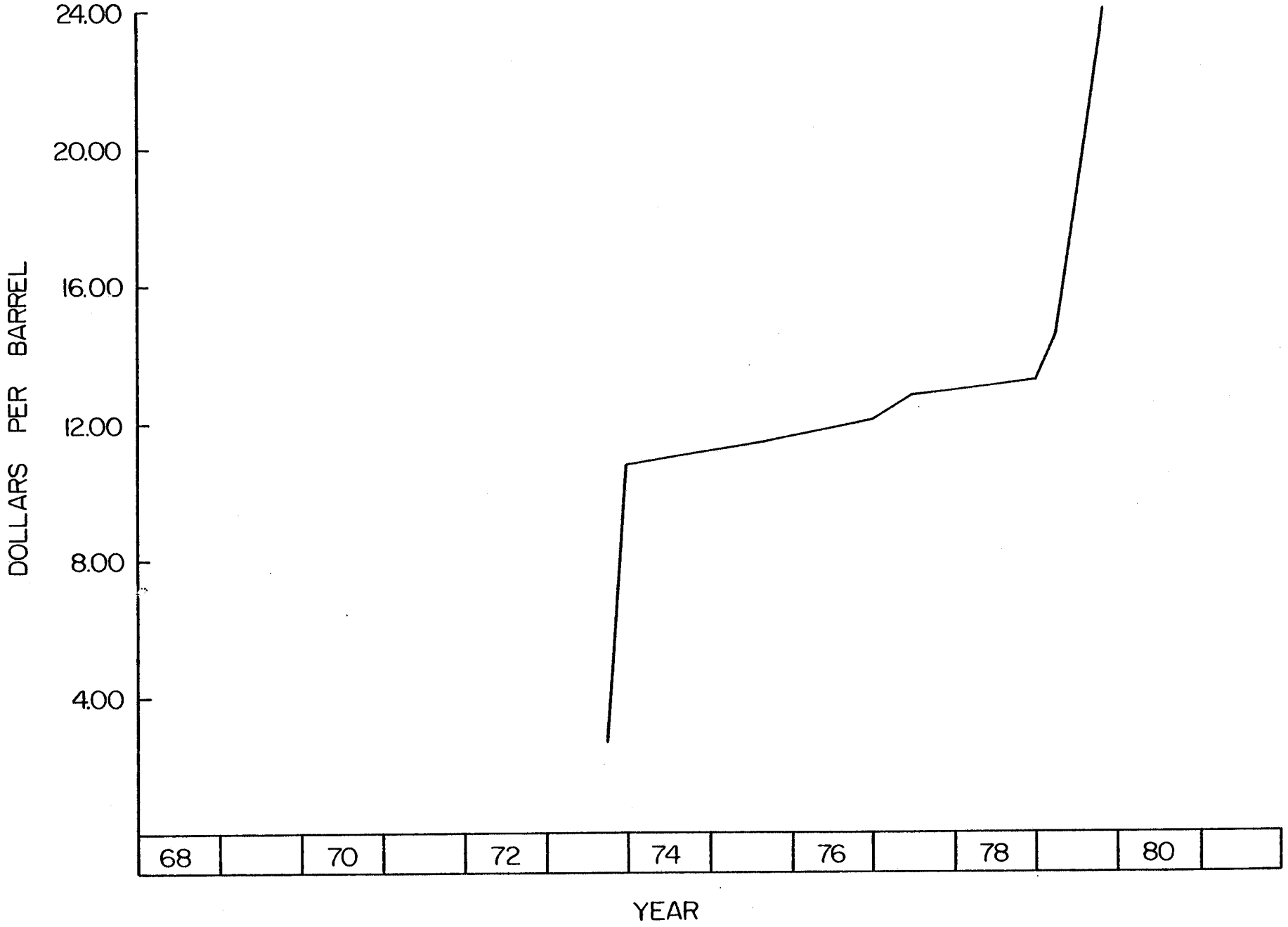


FIGURE 11. BASIC PRICE OF MIDEASTERN CRUDE OIL

After reference 16 and 17