

## ECONOMIC EVALUATION OF OHIO'S FLEXIBLE AND RIGID INTERSTATE PAVEMENTS

By Clifford Ursich, P.E.  
Executive Vice President  
Flexible Pavements, Inc.

Economy and service are the trade marks of Ohio's flexible pavements. This fact has been demonstrated by their ability to consistently deliver superior ride quality, and to provide such quality at low cost both initially and over their life cycle.

That asphalt pavements are cheaper to build and less costly to maintain has been a long held tenet of the asphalt industry. This tenet is founded not in conjecture or promotional theories, but rather, in historical fact. Even after the relentless pounding of traffic, flexible pavements constructed on Ohio's major highways continue to deliver a high level of service at low annual cost.

The fact that Ohio's asphalt pavements have served the public so well and have cost so little is well known within the asphalt community. A person does not have to travel far however, to find many others who do not have good knowledge of the economy and serviceability these pavements have provided. It was for this reason that we at Flexible Pavements, Inc., felt compelled to commission a study of Ohio's interstate flexible pavements to determine the true costs of both flexible and rigid pavements.

An evaluation of the results of the Study indicate that for the pavements studied the asphalt pavements have provided up to 34 years of continuous service without the need for reconstruction or rehabilitation, were less costly to construct and maintain than the contiguous concrete pavements, and the rate of increase in cost for maintaining the asphalt pavements has been less than the rate of increase in cost for maintaining the adjoining concrete and composite pavements.

**Table 1: Pavement Costs on Interstate Highways in Ohio**

		Cost in dollars per square yard		
		Original Project	Discounted Maintenance	
Locations			r = 5%	r = 2.5%
<b>I-71 Franklin to Medina County</b>				
Flexible	FRA-28.92 to DEL-11.50 (1958 Projects)	5.44	2.48	4.07
Rigid	DEL-11.50 to RIC-0.00 (1957-58 Projects reconstructed in 1988)	6.35	6.33	11.17
Rigid	RIC-0.00 to MED-17.46 (1957-58 Projects)	6.35	3.97	6.61
<b>I-75 Hancock and Wood Counties</b>				
Flexible	WOO-0.77 to 5.06 (SB) (1959 Project)	4.63*	2.20	3.58
Rigid	HAN-19.25 to 25.23 (1956 Project part reconstructed in 1990)	5.78*	3.75	7.36
<b>I-75 Wood County</b>				
Flexible	WOO-5.06 to 14.91 (1966 Projects)	5.16	1.82	2.89
Rigid	WOO-14.91 to 19.92 (1966 Project) with tied shoulder costs	5.66	9.12	15.55
	shoulder costs without tied		6.38	11.00
<b>I-275 Hamilton County</b>				
Flexible	HAM-13.91 to 16.22 (1975 Project)	10.62	1.37	2.17

Composite HAM-10.66 to 13.91 (1975 Project—3 inch AC on 9 inch PCC)		12.61	2.27	3.58
I-275 Hamilton and Clermont Counties				
Flexible	HAM-32.27 to 34.91 (1968 Project)	4.94	2.26	3.86
Flexible	CLE-0.00 to 10.98 (1970 Project)	5.08	2.03	2.99
Rigid	HAM-30.96 to 32.27 (1964 Project)	5.79*	3.32	5.66
I-475 Lucas County – all projects opened at the same time				
Flexible	LUC-5.25 to 8.95 (1966 Project)	5.62*	2.64	4.08
Rigid	LUC-0.09 to 5.25 (1964 and 66)	6.44*	2.88	4.90

Notes:

\*Cost based on ODOT's average contract bid prices for the project year – actual prices not available.

Maintenance costs were discounted to the original project year using the discount rated indicated.

The intent of the Study was to evaluate all Ohio interstate pavements constructed of asphalt (i.e. the flexible pavement concept) and the adjoining concrete (rigid) or composite pavements for their actual costs. Actual costs being the dollars spent, to date, to construct and maintain the pavements. The Study was conducted by Willis Gibboney, P.E., former Ohio DOT Flexible Pavement and Interstate Pavement Engineer.

Interstate pavements were selected for the cost study because they are typically designed, constructed and maintained to similar standards, and traffic loading is much the same on adjacent pavements, and as such, more readily permit the comparison of the flexible and rigid pavement concepts.

Project data for the Study is tabulated from plans, contract files, and field documentation of the Ohio Department of Transportation (ODOT). The original pavement construction costs are for the mainline pavement layers above the subgrade. Maintenance costs are for contracted items of work to maintain, rehabilitate or reconstruct the mainline pavement.

To account for the time value of money, contract maintenance costs were discounted to their present worth during the original construction year. Discount rates of 5% and 2.5% were used to show the reader the effect of the discount rate on the Study results. For the purpose of making economic comparisons between pavement types, a 5% discount rate was used because that rate was being used by the Ohio Department of Transportation around the time the original projects were constructed.

The Study permits the comparison of flexible and rigid pavement concepts to determine which has been the most economical. For a cost comparison to be meaningful it must be based on data obtained from pavements which are similar in age, traffic, design parameters and environment. Of the pavements shown in the above table, four locations, I-71, Franklin to Medina County, I-75, Wood County, I-275, Hamilton County, and I-475, Lucas County are sufficiently similar to permit such comparison.

The first location, I-71, Franklin to Medina County, begins with the asphalt pavement section just south of I-270 in Franklin County and proceeds north to Delaware County mile post 11, at which point the pavement type becomes concrete, and continues north to the State Route 18 interchange in

Medina County. Pavements were let to contract for construction in 1957 and 1958. All projects were open to traffic within an 8-1/2 month period of time.

Since the time of original construction, some sections of the concrete pavement included in the Study have been reconstructed. These reconstructed concrete sections of pavement are compared separately to the asphalt pavement. This was done because the application of the reconstruction costs to adjacent concrete pavement sections artificially inflates the cost per square yard for the non reconstructed concrete pavements. Figures 1 and 2 permit us to observe, for comparison, the actual cost of constructing and maintaining both pavement types.

### Present Worth in 1960 of Total Contract Costs (5% Discount Rate)

#### Interstate 71

Flexible: FRA-28.92 to DEL-11.50

Rigid RIC-0.00 to MED-17.46

—◆— Rigid —■— Flexible

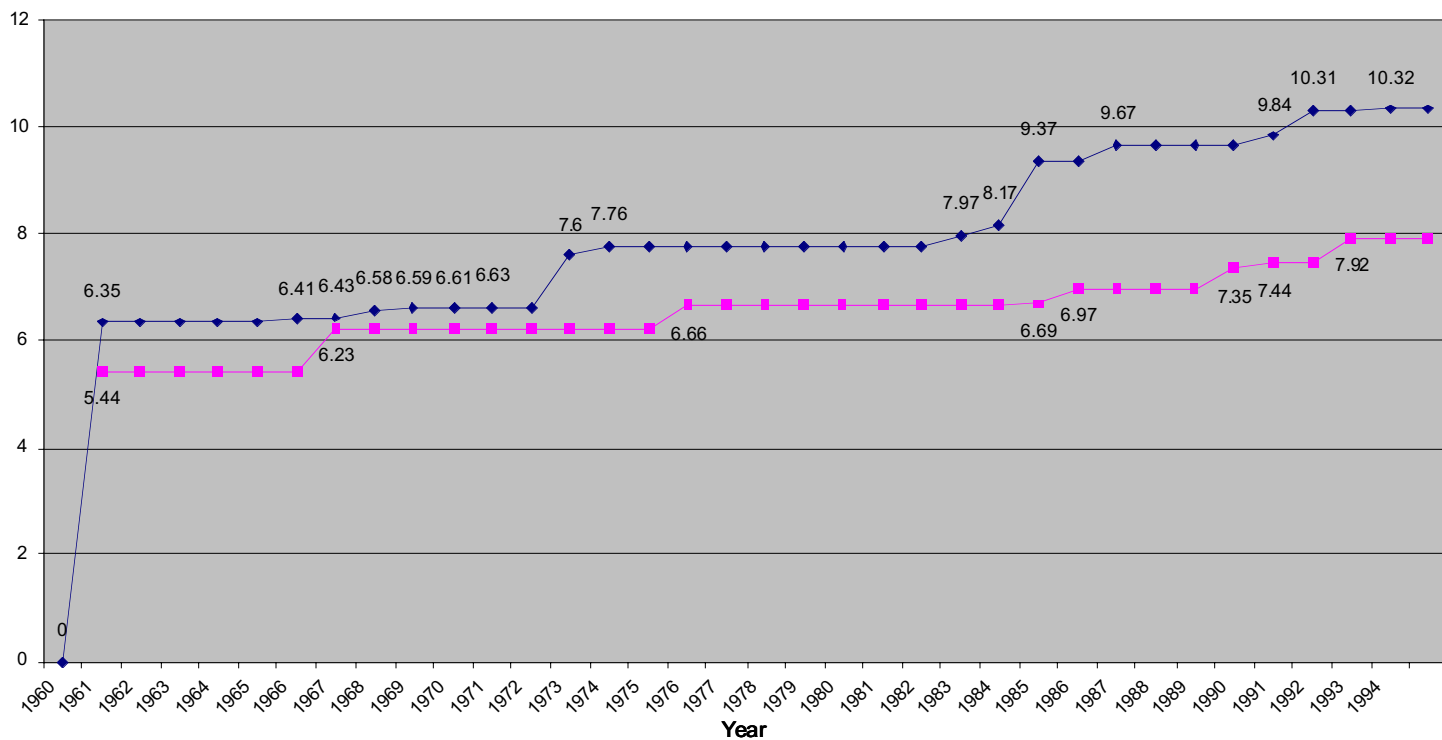


Figure 1

The Figures are graphical plots of cost versus time. The cost over time for the asphalt (flexible) pavement section is shown as a solid line. The cost over time for the concrete (rigid) pavement section is shown as a dashed line. Each step in the graph is an indicator that contract maintenance had occurred somewhere within the pavement section at the year the cost per square yard “stepped up” (increased). The cost per square yard shown in year 1960 is the cost for the original construction of the mainline pavement. From the graphs it can be seen that the asphalt pavement has been significantly more economical than its concrete counterpart. To date, the asphalt pavement has cost \$2.40 (1960 dollars) per square yard less compared to the concrete section RIC-

0.00 to MED-17.46 and \$4.76 (1960 dollars) per square yard less compared to DEL-11.50 to RIC-0.00.

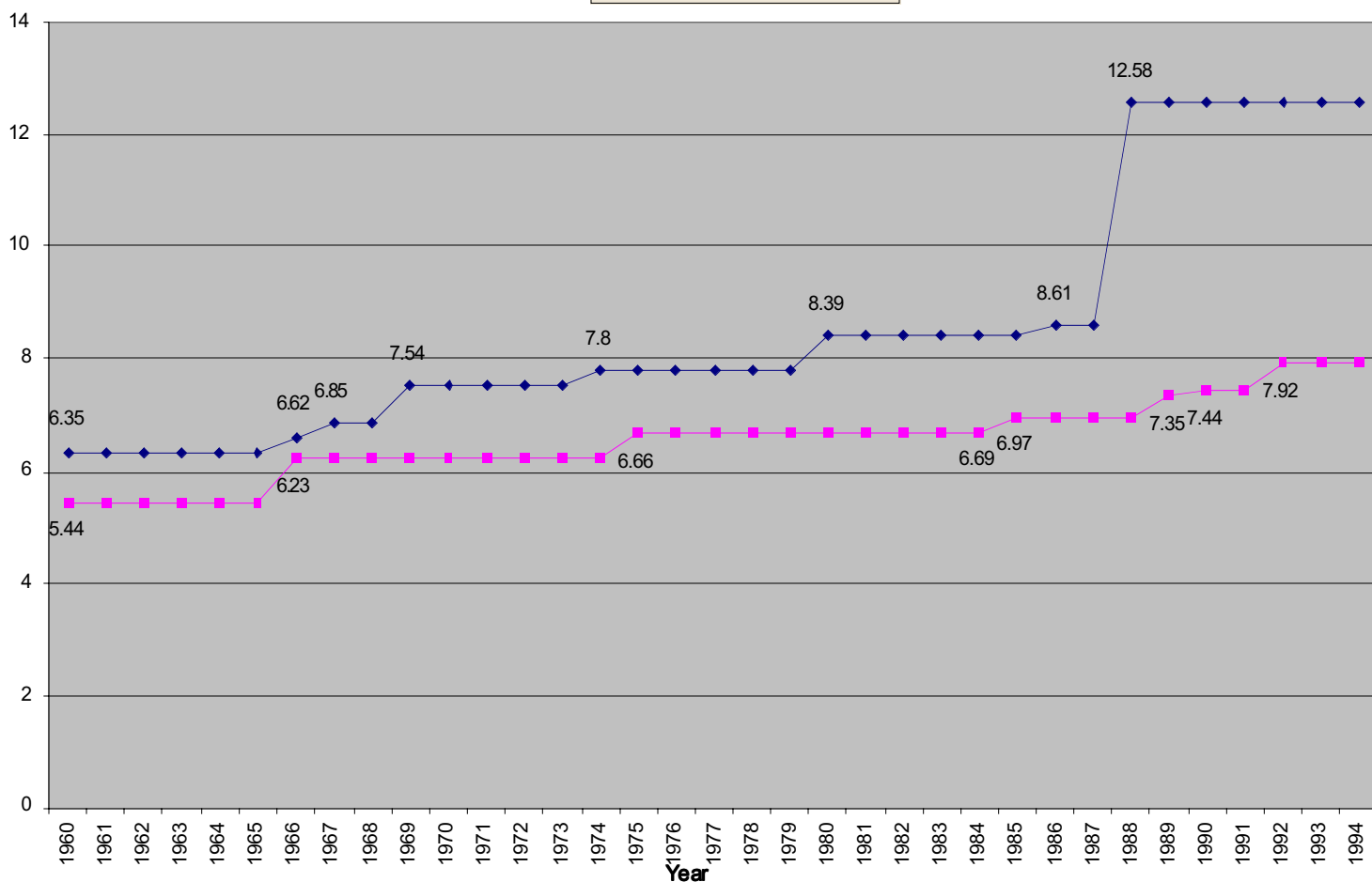
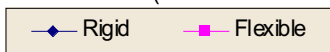
Figure 2 provides added insight. The concrete pavement reconstruction costs incurred in 1988 make evident the future expenditure of funds required of this pavement type. In contrast, the asphalt pavement shows only a modest increase in the cost per square yard through time, evidencing its good economy. Also, there exists no indication that reconstruction of the asphalt pavement will be needed in the near future (PSI=3.8, PCR=90, SD=4.0 -- 1994 data).

**Present Worth in 1960 of Total Contract Costs (5% Discount Rate)**

**Interstate 71**

Flexible: FRA-28.92 to DEL-11.50

Rigid: DE-11.50 to RIC-0.0 (Reconstructed in 1988)



**Figure 2**

The second location which allows us to compare the economy of flexible and rigid pavement types is I-75, Wood County. Both the asphalt and concrete pavements were constructed in 1966 and opened to traffic the same day in 1968.

Looking at the graphical plot (Figure 3) of cost versus time (years) it can be seen that the initial cost of construction for the two pavement types were similar, the asphalt pavement being the lesser of the two. The plot permits us to see that through time the cost to maintain the asphalt pavement has increased at a steady, yet moderate rate. The concrete pavement saw a dramatic increase in the cost per square yard due to concrete pavement repair (CPR) occurring in 1987.

### Present Worth in 1966 of Total Contract Costs (5% Discount Rate)

#### Interstate 75

Flexible: woo - 5.06 to 14.91 Rigid: woo-14.96 to 19.92

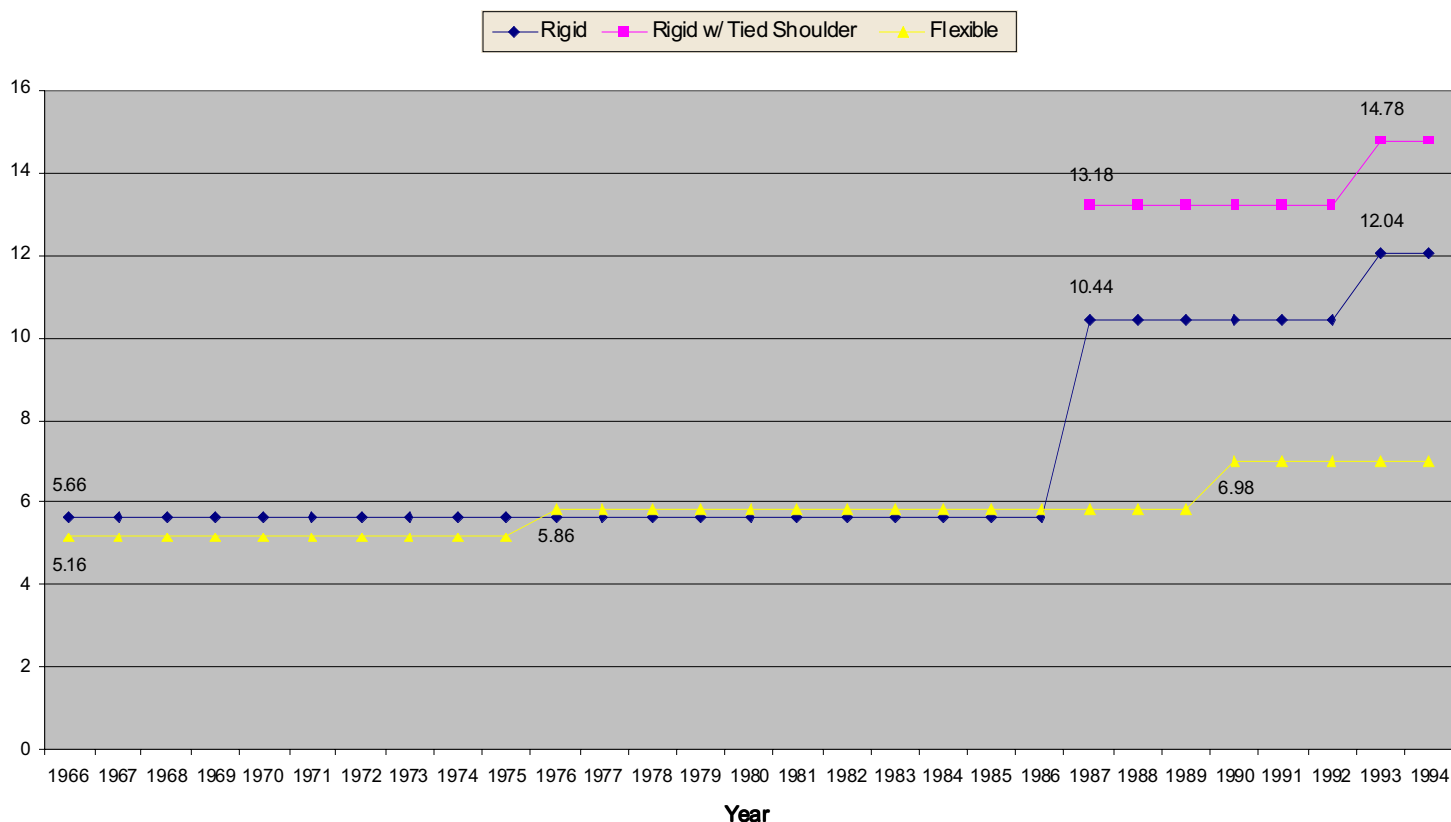


Figure 3

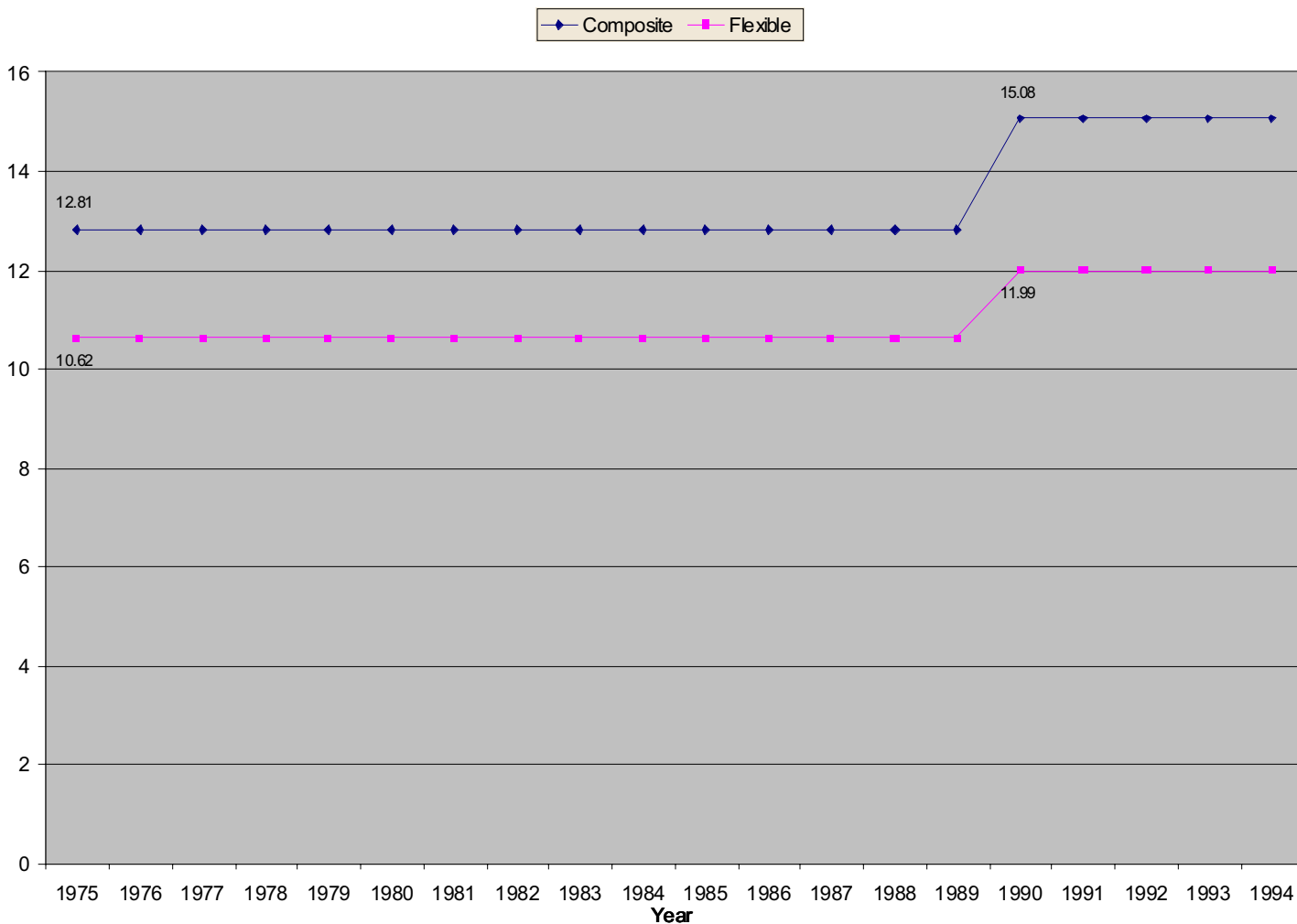
The CPR called for the removal of existing shoulders and replacement with tied concrete shoulders. Figure 3 shows the cost per square yard for the concrete pavement with and without the cost for the tied concrete shoulders included. The Study includes the cost for tied shoulders because current thinking is that tied shoulders strengthen the edge of the mainline pavement.

The cost difference between the asphalt and concrete pavements, on these sections of I-75, is \$5.06 (1966 dollars) per square yard when tied shoulders are not included. When tied shoulders are included, the asphalt pavement was found to be \$7.80 (1966 dollars) per square yard less costly than concrete. As in the case of the asphalt sections on I-71, the asphalt pavement condition provides no evidence of needing reconstruction (PSI=4.0, PCR=90, SD=4.8 -- 1994 data).

Location 3, I-275 in Hamilton County, permits the comparison of flexible and composite pavement costs. Actually this again is a comparison of rigid and flexible pavements. The relatively thin, flexible asphalt surfacing cannot alter the rigid behavior of the relatively thick, plain portland cement concrete. If you will permit the expression, “the tail cannot wag the dog.”

**1975 Present Worth of Total Contract Costs (5% Discount Rate) Interstate 275**

Flexible: HAM - 13.91 to 16.22 Composite: HAM - 10.66 to 13.91



**Figure 4**

Both the asphalt and composite pavements were let to contract in 1975, having an original contract cost of \$10.62 and \$12.81 (\$/sy in 1975 dollars) respectively. Figure 4 further indicates that in addition to the higher initial cost, the cost to maintain the composite pavement exceeds that of the asphalt pavement. The total cost of the asphalt pavement, to date, is \$3.09 (\$/sy in 1975 dollars) less costly than the contiguous composite pavement.

Regarding the present condition of the asphalt section, performance measures indicate satisfactory service and structural condition (PSI=3.8, PCR=76, SD=13.0 -- 1994 data).

The final pavement considered in the economic evaluation was I-475, Lucas County. Pavements were constructed from the Wood/Lucas County line, north to milepost 8.95. The rigid section (milepost 0.09 to 5.25) was let to contract in three projects, using JRCP, beginning with the first in 1964 and followed by two additional projects in 1966. The flexible section (milepost 5.25 to 8.95) was let to contract in 1966. The mainline of all pavements were opened to traffic at the same time. The concrete pavement let to contract in 1964 was opened to traffic prior to the completion of the contiguous pavements; however, traffic was confined to collector and distributor pavements at the U.S. 24 interchange. Only the mainline pavement was included in the economic analysis.

The cost to construct and maintain these pavements once again shows an economic advantage in favor of the flexible pavement. Figure 5 graphically shows this fact. The total construction and contract maintenance costs for the asphalt pavement has been \$8.26 per square yard (1966 dollars) as compared to \$9.32 per square yard (1966 dollars) for the contiguous concrete pavement. Performance measures further indicate that the flexible pavement will provide satisfactory service into the future (PSI=3.7, PCR=77, SD=8.4 -- 1994 data).

**1966 Present Worth of Total Contract Costs (5% Discount Rate)**  
 Interstate 475 Flexible: LUC-5.25 to 8.95 Rigid: LUC-0.09 to 5.25

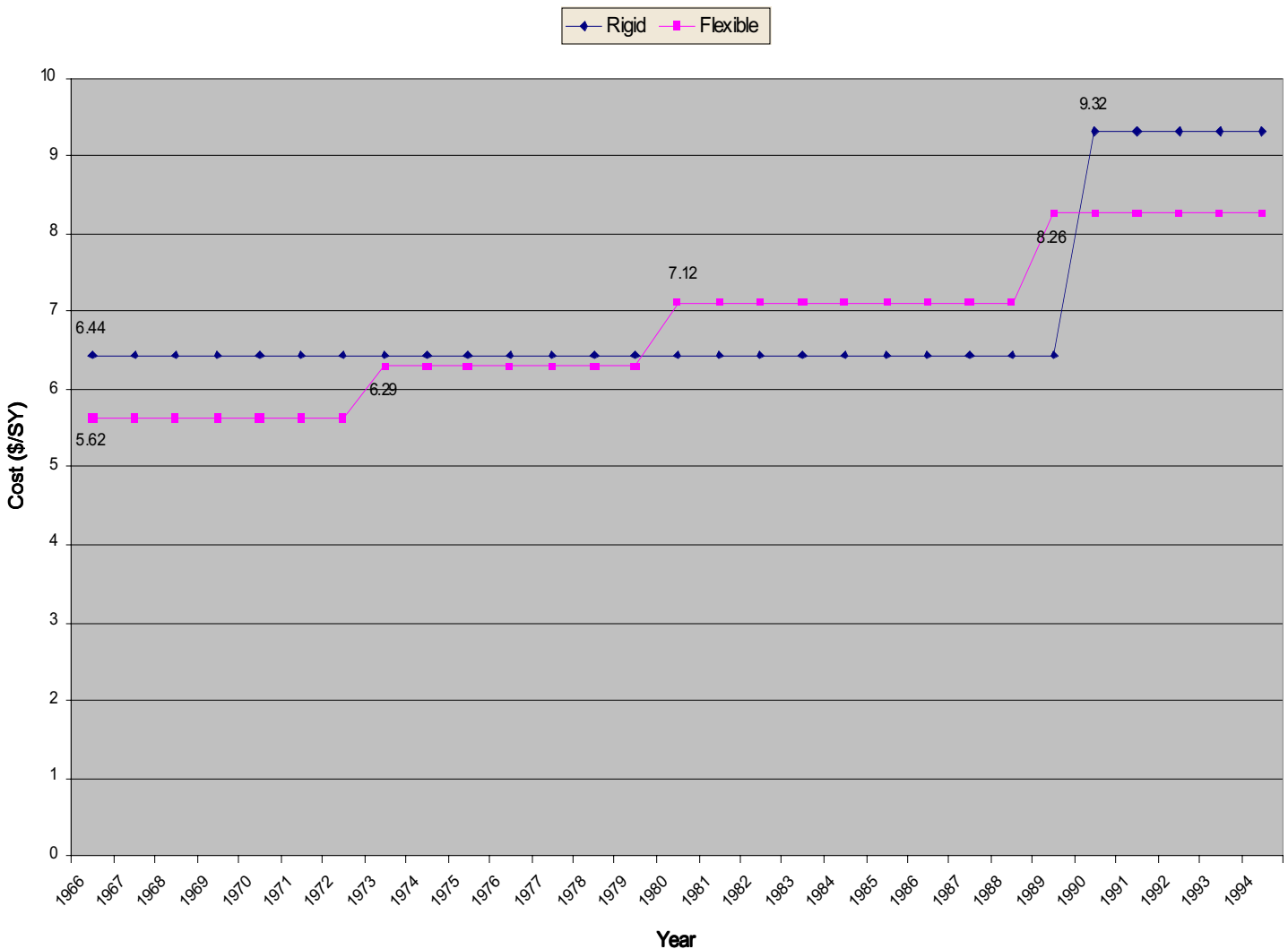


Figure 5

The incremental cost increases over time shown in figures 1 through 5 bring to light trends in the cost to construct and maintain both flexible and rigid pavements. The initial construction costs of the flexible pavements have in all cases been less than the costs of the contiguous rigid pavements. The contract maintenance costs for the flexible pavements reflect modest increases in cost over time primarily due to wearing course restoration and some structural enhancement. The rigid pavements, on the other hand, have all consistently shown a major increase in the cost per square yard when rehabilitative and reconstructive work became necessary.

The economy of using the flexible type pavement is made evident by evaluating Figures 1 through 5. Conclusions which can be drawn are:

- The asphalt pavements have provided up to 34 years of continuous service without the need for reconstruction or rehabilitation.
- The asphalt pavements were less costly to both construct and maintain than the contiguous concrete and composite pavements.
- The rate of increase in cost for maintaining the asphalt pavements is less than the rate of increase in cost for maintaining the adjoining concrete and composite pavements.

“The initial and subsequent costs compiled in the Study confirm a significant economic advantage in favor of the asphalt pavements over the adjacent concrete pavements not only in the short but in the long run as well. The cost differences would even be greater if other costs such as administrative, maintenance of traffic, and user delay were included.”<sup>1</sup>

---

<sup>1</sup> Gibboney, Willis B., “Flexible and Rigid Pavement Costs On The Ohio Interstate Highway System”, December, 1995.