

Transportation of Mineral Aggregates in Indiana¹

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Abstract

Mineral aggregates, such as crushed stone, sand, and gravel, are essential to the expansion and renewal of urban areas and to the improvement of highway systems. Because of the mineral producer's ability and willingness to improve production techniques and to absorb increasing costs, the price of mineral aggregates has remained remarkably stable. The stability of f.o.b. prices, depletion, and the exclusion by zoning of some well-located deposits has caused transportation costs to become an increasingly important part of the overall price of mineral aggregates in Indiana.

Published and unpublished rate schedules show that trucking is the most economical method of transporting aggregates up to a distance of about 35 miles. Between 35 and 230 miles railroad rates appear to be the most economical, although substantial variations exist between companies and between northern and southern Indiana. Barge transportation is most economical for distances of more than 230 miles. Average charges are approximately 2.5 to 5 cents per ton mile plus 25 cents per ton base charge for road transport, 0.82 cents per ton mile plus \$1.40 per ton base charge for rail transport, and 0.45 cents per ton mile plus \$2.25 per ton base charge for water transport.

Introduction

Most mineral aggregates, such as crushed rock, sand, and gravel, are low-value, high-volume commodities that are essential to the expansion and renewal of housing units, transportation systems, and work facilities for urban populations. Under normal conditions, the construction commodities can bear only nominal transportation charges and must be produced as near the market area as is economically, socially, and geologically feasible.

Numerous economic and social problems develop and become more serious as rapid urbanization increases the demand for construction materials. Producing companies that have served a growing market for any length of time may ultimately be faced with increasing operating costs because of thicker overburden, higher lift or longer quarry haul, higher incidence of equipment repair, increased pumping, and anti-pollution requirements. These problems, however, are mostly overshadowed by the proximity of the production site to the market area. The economic advantage of good site location can, and commonly does, result in an increased number of complaints about vibration, traffic congestion, noise, physical danger, and air and water pollution, by the local residents. The social incompatibility of producer and consumer creates a tendency for new production sites to be selected or relocated in less densely populated areas. However, most production sites are selected in areas served by

¹The data used in this paper were compiled in 1966-1967 while the author was employed by the Indiana Geological Survey, and are used with the permission of Dr. John B. Patton, State Geologist, Bloomington, Indiana.

good highways and if unplanned 'strip' urbanization occurs along these transportation routes, then the social conflicts are repeated.

Geologic and geographic distribution of commercial grade deposits is another major factor to be considered in the production and subsequent marketing of mineral aggregates in an urban area. Geologic conditions in Indiana are such that large areas in the northern, southwestern, and southeastern parts of the State are covered with thick glacial drift and fine-sized outwash, or are underlain by sandstone, shale, or thin limestone. Aggregates, especially the coarser sizes (plus 1¼ inch), must be transported into these areas by road or rail, and the cost is considerable. For example, coarse aggregates that are normally priced about \$1.50 per ton f.o.b., commonly retail for \$3.10 per ton in Vincennes, and \$2.30 to \$3.15 per ton at stockpiles in Indianapolis, and for more than \$4.00 per ton in South Bend.

The net effect of the economic, social, and geologic factors, and the low capital requirements (compared to other mining operations,⁸) of mineral aggregate production, has been to create a highly competitive industry in Indiana. Average prices of crushed rock, sand, and gravel have remained quite low (the average price of sand and gravel was \$0.94 and crushed rock \$1.27 per ton in 1966 as compared to \$0.72 and \$1.20 per ton, respectively, in 1947), and the number of producing quarries has remained reasonably constant (80 to 89) during the past 20 years. Company data from the sand and gravel industry are not readily available, but an analysis of crushed stone operations in Indiana (2) has shown that most of the 35 independent company failures that occurred between 1947 and 1965 were in areas where production facilities were relatively concentrated (5 to 10 quarries within 20 miles). Most of the failures in these highly competitive areas are believed to be the result of both the market size and the minimization of the protective effect of transportation costs.

Highway Transport

During the first quarter of the twentieth century, most mineral aggregates were shipped by rail or used in the immediate vicinity of the quarry or pit. Producing companies began trucking their own aggregate about 1925, and later, in the 1940's, started using owner-operated vehicles. This was a workable arrangement for small single-quarry companies but mergers, purchases, and normal growth brought larger integrated companies and a definite trend toward the use of contract haulers. Today more than three-fourths of the aggregate produced in Indiana is transported to the consumer by trucks, most of which are owned by independent trucking companies.

Contract haulers are required to file their current freight rates with the Public Service Commission, State Office Building, Indianapolis. Typical published rates for three independent trucking companies are shown in Table 1. The wide variations in charges for hauling crushed rock, sand, and gravel on a cents per ton-mile basis suggest that perhaps some "ghost" rates or other factors may be included in these data.

Haulage rates are, in fact, commonly bid on a single job basis and depend largely on the size of the job and traffic and road conditions between the production site and the construction project. Some of the actual 1967 rates charged to one rural producer of crushed rock are shown in Figure 1. The basic charges are approximately 5 cents per ton-mile for the first 6 miles, 3 cents per ton-mile for the next 18 miles, and 2½ cents per ton-mile thereafter. A base charge of 25 cents per ton was also applicable. These charges are similar, but are not necessarily identical to those reported to be in effect in other areas of the country (1, 4, 5, 7) and Canada (6, 8).

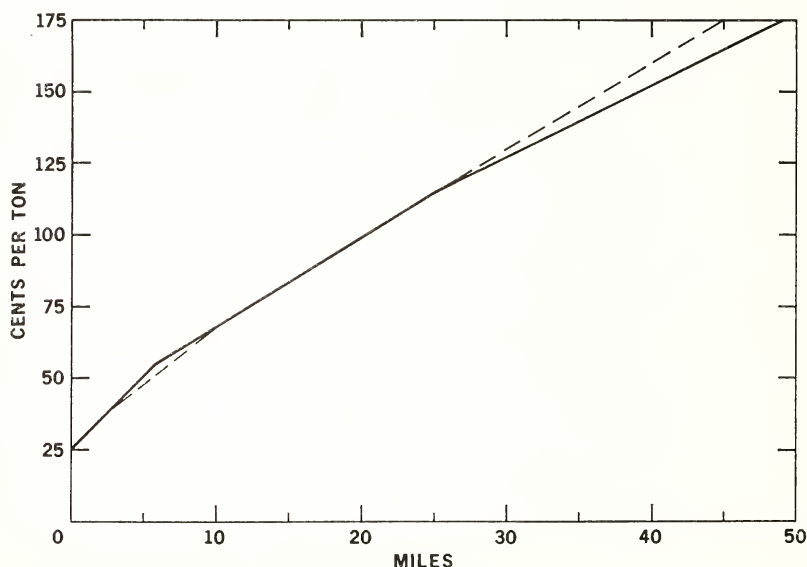


Figure 1. Two unpublished tariffs for highway transport of mineral aggregates in a rural area.

TABLE 1. *Some published rates for highway transportation of mineral aggregates in Indiana*

Miles	Cost per ton (cents)	Miles	Cost per ton (cents)	Miles	Cost per ton (cents)
1-5	25	1-10	200	0-5	55
5-10	45	11-30	270	5-10	65
10-15	70	31-50	290	10-15	80
15-20	95	51-80	350	15-20	100
20-25	120	81-110	390	20-25	120
25-30	145	111-150	430	*See footnote.	
30-35	170	151-200	530		

*For 30 miles or more, cost is 3.5 cents per ton-mile.

The average f.o.b. price of crushed rock in Indiana is approximately \$1.27 per ton, thus a haul of about 31 miles in some rural areas will effectively double the price of the aggregate to the consumer. In urban and some suburban areas, the transfer distance required to double the f.o.b. price may be as short as 9 or 10 miles, depending mostly on time and traffic conditions. The cost of sand and gravel, which normally sells for less than \$1.00 per ton, can be doubled by a transfer distance of only 6 to 8 miles in some densely populated areas.

Rail Transport

Rail transportation is used to haul crushed rock and minor amounts of sand and gravel into northern and western Indiana, and into the neighboring states. A substantial part of the demand for crushed rock in Indianapolis is also satisfied via rail transport of material produced in the surrounding counties (3). Freight rates for rail transportation of mineral aggregates vary widely and, in effect, between areas of the State. Average freight rates discussed here are for point-to-point hauls as filed with the Public Service Commission. Loading and unloading of freight cars is normally the responsibility of the shipper and the cost varies from about 20 to 40 cents per ton, depending upon the type of rolling stock and equipment available.

Variations in published point-to-point rates range from about 10 cents per ton-mile to less than one cent per ton-mile with minimum charges ranging from \$0.99 to \$1.84 per ton. Reasons for these variations may include complex routes requiring one or more transfers, bulk rates

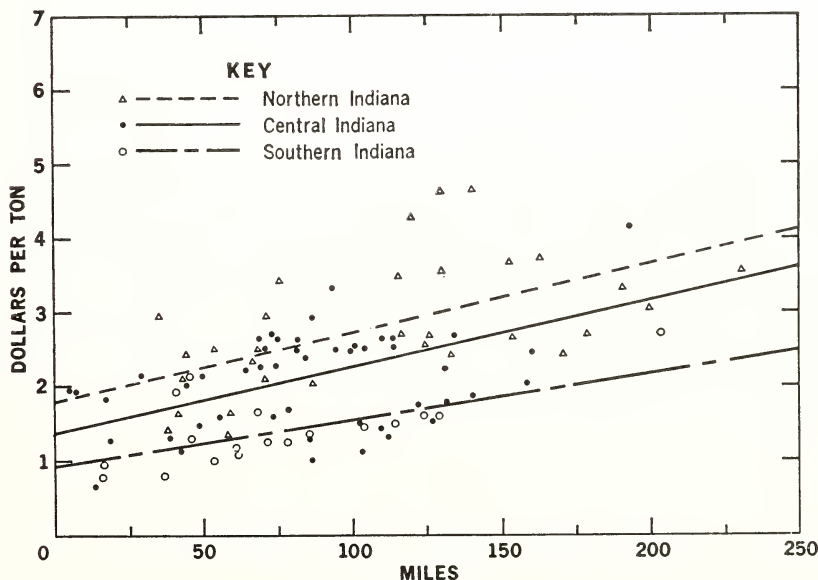


Figure 2. Some published point-to-point tariffs for rail transport of mineral aggregates.

for high annual tonnages or large shipments, or other market conditions.

The regression lines shown in Figure 2 were derived from estimated track mileage and published rates for point-to-point hauls. Most of the lower rates were in effect in southern Indiana where the average charge was .61 cents per ton-mile plus 99 cents per ton minimum charge. In northern Indiana, where quarries are few and moderately long hauls are common, the charges for rail transportation were approximately .92 cents per ton-mile plus \$1.84 per ton minimum. The average rate for all data considered in Figure 2 is .82 cents per ton-mile plus \$1.40 per ton minimum.

Water Transport

A few of Indiana's crushed rock and sand and gravel operations are strategically located along the bluffs and flood-plains of the Ohio River, and are able to take advantage of barge transportation for long hauls. Company-owned or leased barges of 500 to 1,200 tons capacity are used to ship aggregates to major markets in southwestern Indiana, Illinois, Kentucky, Ohio, and West Virginia. Contract haulers rates are not regulated by the Interstate Commerce Commission, but are commonly quoted by the individual companies according to market conditions and are subject to change. In late 1966, one barge company established some point-to-point transportation rates of .3 to 1.02 cents per ton-mile, f.o.b. in barge, with a minimum load of 500 tons per barge. Another company quoted an average rate of .81 cents per ton-mile, and a third company quoted .4 to .65 cents per ton-mile for minimum barge loads of 1,200 tons (plus 50-100 cents per ton for loading and 100-200 cents per ton for unloading.) The data shown in Figure 3 are published point-to-point rates from docks in Indiana and Kentucky. Relatively high (compared to the

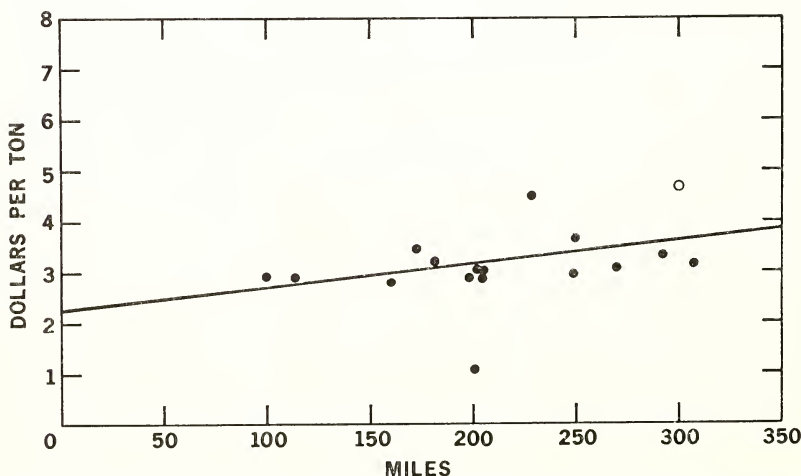


Figure 3. Some published point-to-point tariffs for water (barge) transport of mineral aggregates.

cost of aggregate) loading and unloading charges normally prohibit the use of barge transport for all but the longer hauls, although direct loading via conveyor belt from processing plant to barge is possible at some sites and permits reduced handling charges and greater distance of economic haul. The use of flat-deck barges can further reduce the cost of loading and unloading to about 25-50 cents and 50-100 cents per ton, respectively.

Summary and Conclusions

Trucking will probably continue to be the dominant mode of mineral aggregates transportation because of the ease of loading and the ability to deliver directly to the point of consumption. Factors of production and transportation generally restrict deliveries to within about 35 miles of the production site, and it is within this radius that trucking appears to be the most economic (Figure 4). Geologic conditions do not permit large scale open pit production of mineral aggregates in northern and southwestern Indiana and it is to these areas, which are mostly more than 50 miles from production, that railroads provide the most economic means of transportation. Lack of suitable crushed rock aggregate in some parts of the neighboring states has allowed some Indiana deposits that are strategically located on the bluffs of the Ohio River to be exploited and the aggregate shipped by barge to Illinois, Ohio, Kentucky, and West Virginia. Water transport appears to be the most economic method for distances of more than 230 miles, but direct loading facilities from plant to barge may extend the competitive range.

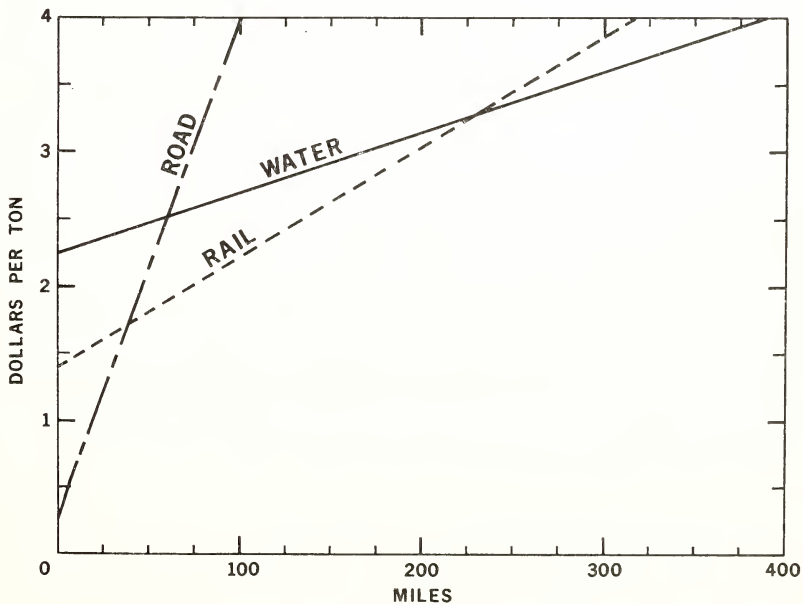


Figure 4. Comparison of average tariffs for highway, rail, and water transport of mineral aggregates.

Social conditions and the concentration of major markets on the fringe of expanding metropolitan areas, in 'satellite' cities, and in highway construction projects, create a tendency for aggregates producers to locate or relocate their open pit operations in the more sparsely populated areas if geologic conditions and transportation facilities are amenable. Thus, continued urbanization and the depletion of some of the centrally-located deposits may require longer transportation hauls than those previously considered feasible and competitive. The cost of longer transportation must ultimately be reflected in higher costs of construction, assuming no major changes in technology. Greater truck or railroad car capacity, better highways, unit trains, and some economies of scale in larger and more remote production facilities, will counterbalance the increased transportation costs to some degree. Crushed rock and stone sand from underground mines located within some urban areas offer an alternative to increasing transport cost, but the industry has not yet developed this possibility to any great extent. Land values, and the demand for underground shelters, reservoirs, waste disposal areas, or constant temperature storage space may require that we examine the open space left within some urban areas for the possibility of obtaining mineral aggregates and creating usable underground space.

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