Coal Shiploaders for the Mississippi

An Evaluation of Design Concept

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Summary

The author compares various shiploader designs and gives price estimates on the basis of mid 1980 bids covering marine construction and equipment. Three schemes were compared: traveling loader, dual radial loaders and single linear loader. These systems are ranked according to their production rate, manpower cost, system availability, power consumption, mechanical and electrical maintenance, marine and structural maintenance and for the case of a major shutdown. While these rankings only give a general picture, a detailed analysis can lead to exact capital costs and will underline the economic value of utilizing the best available technology for the loading of large coal arrives on the Mississippi.

1. Introduction

There are a number of coal export terminals in the planning stage on the Mississippi. As the ship loading installations represent a substantial part of the total investment, utilization of the best, most economical design can have great impact on the overall economics of the terminal.

Shiploading installations are expensive on the Mississippi, due to hurricane winds and poor soil conditions combined with a 20 to 40 ft variation in river elevation. Depending on the location, a berth providing 50 ft of water depth at low water level may have up to 90 ft of water depth at high water, considerably increasing the cost of the marine structures.

In connection with a current project, at a location with large variation in water levels, we had the opportunity to compare various designs, on the basis of mid 1980 bids covering marine construction and equipment.

2. Criteria

The performance and operating criteria are listed in Table 1.

Three schemes were compared: traveling loader, dual radial loaders and single linear loader. Single radial loader was not included, as it was found less economical for comparable vessel sizes in a detailed analysis performed previously [1].

The speed and accuracy of obtaining costs were greatly facilitated by drawing upon a number of previously completed installations in each category.

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Table 1

Shiploader capacity	8,000 t/h
Vessels to be loaded without shifting	20,000 DWT — 100,000 DWT
Vessels to be loaded with shifting	150,000 DWT
Design wind velocity	110 miles/h
Conveyor belt width	84 inches
Operator cab location	over hold, for complete visibility
Environmental protection standards	high
Conveyors and transfer stations	enclosed
Structures and equipment designed for minimum maintenance	yes
Water depth at low water at dock face	55 ft
Water depth at high water at dock face	90 ft
Distance of levee to dock face	600 ft
Levee elevation over highest water	5 ft
Conveyor clearance required over levee	18 ft
Soil soft to stiff clays to 90 ft below mudline, over dense sand	
Bearing capacity of 48 inch diameter pile	400 ton
Bearing capacity of 24 inch diameter pile	200 ton

3. Traveling Loader Scheme

The highest capacity traveling coal loader for river conditions is at Immingham, Great Britain, designed by Soros Associates. Poor soil, high currents and a tide variation of 24 ft requiring multi-story fendering are similar to conditions on the Mississippi (Fig. 1). For a present day installation the elevated dock conveyor and the traveling tripper feeding the shiploader would have to be enclosed, [2] for improved environmental protection, as shown on Fig. 2. A plan view of the installation costed is shown in Fig. 3; the capital costs are summarized in Table 2.

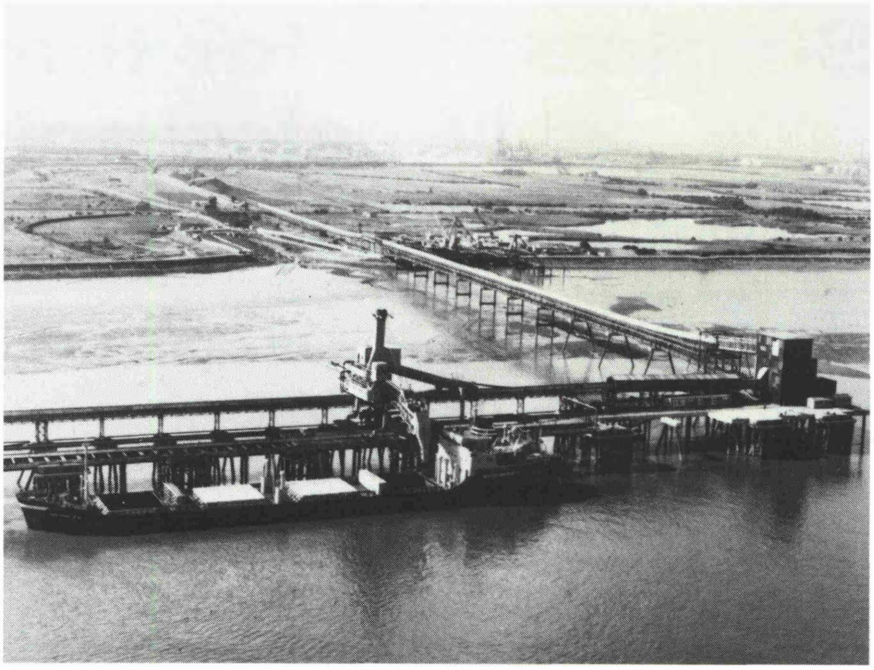

Fig. 1: Highest capacity traveling coal loading installation for river conditions, at Immingham, Great Britain, is of Soros design. Multi-story fenders accommodate 24 ft variation in water depth

Fig. 2: Traveling tripper and dock conveyor of Soros design, with enclosed C gallery for improved environmental protection, now handling coal at Morehead City, NC, USA

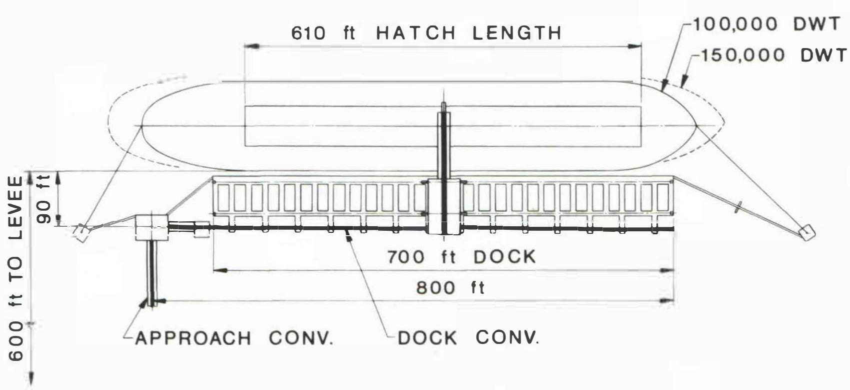

Fig. 3: 8,000 t/h Traveling Loader Plan

Table 2

Marine Construction	
90 ft wide, 700 ft long dock, with multi-story fendering	$ 9,850,000
Transfer house foundations	480,000
Two mooring dolphins including walkways	1,050,000
510 ft long conveyor foundations	320,000
	$ 11,700,000
Shiploader	
Traveling shiploader with variable length chute and rotating spout	$ 6,200,000
Conveyor system	
510 ft long 84 inch approach conveyor	$ 325,000
510 ft steel galleries and supports	935,000
Transfer station and dock conveyor drive house	400,000
800 ft long 84 inch dock conveyor	700,000
800 ft elevated C gallery and supports	1,450,000
	$ 3,810,000

4. Dual Radial Loader Scheme

A dual radial loader scheme of Soros design [3] for 100,000 DWT vessels is shown in Fig. 4. A plan of the installation costed is shown in Fig. 5. Transfer stations and conveyors are enclosed. The capital costs are summarized in Table 3.

Table 3

Marine Construction	
3 Multi-story breasting dolphins, with walkways	$ 1,500,000
2 Mooring dolphins, with walkways	1,150,000
2 Curved rail foundations at 240 ft arc length	3,340,000
2 Loader pivot and transfer foundations	980,000
Two-way transfer house foundation	560,000
400 ft long approach conveyor foundations	240,000
	$ 7,770,000
Shiploader	
Two 84 inch radial shiploaders with 280 ft long bridge, 120ft long traversing boom with variable length chute and rotating spout	$ 8,900,000
Conveyor System	
400 ft long, 84 inch wide approach conveyor	$ 250,000
400 ft steel gallery and supports	720,000
Two way transfer and drive house	700,000
2—140 ft long 84 inch cross conveyors	480,000
2—100 ft long steel galleries	320,000
2 Transfer stations at loader pivots	600,000
	$ 3,070,00

5. Linear Loader Scheme

The linear loader [4] principle is illustrated in Fig. 6. A river installation of an 8,000 t/h linear loader, with multi-story fenders for 30 ft water level variation is shown in Fig. 7. The plan of the installation costed is shown in Fig. 8. It includes enclosed conveyors and a second generation linear loader design. The capital costs are summarized in Table 4.

Table 4

Marine Construction	
3 Multi-story breasting dolphins with walkways	$ 1,500,000
2 Mooring dolphins with walkways	1,150,000
440 ft long linear runway	3,350,000
1 loader pivot and transfer foundations	830,000
365 ft long approach conveyor foundations	360,000
	$ 7,190,000
Shiploader	
84 inch linear loader, 280 ft long bridge, 160 ft long luffing and shuttling boom with variable length chute and rotating spout including transfer structure at pivot	$ 7,600,000
Conveyor System	
365 ft long 84 inch approach conveyor	$ 230,000
365 ft long steel gallery and supports	660,000
Transfer station at loader pivot	300,000
	$ 1,190,000

6. Capital Cost Comparison

Table 5

	Traveling Loader	Dual Radial	Linear Loader
	(Cost in $ 1,000)		
Marine construction	11,700	7,770	7,190
Shiploader	6,200	8,900	7,600
Conveyor system	3,810	3,070	1,190
Total	$ 21,710	$ 19,740	$ 15,980

7. Operating and Maintenance Costs

To evaluate a variety of operating aspects, the 3 schemes were ranked 1, 2 or 3 in order of preference.

7.1 Production Rate

With Dual Radial, the material flow need not be interrupted during hatch shifting when the same grade of coal is loaded. With the linear, all moves are "forward" moves. With the traveling loader half of the moves are "backward" moves, where the dock belt has to be emptied first, requiring more time.

Fig. 4: Dual Radial Loader installation of Soros design at Port Latta for 100,000 DWT ships

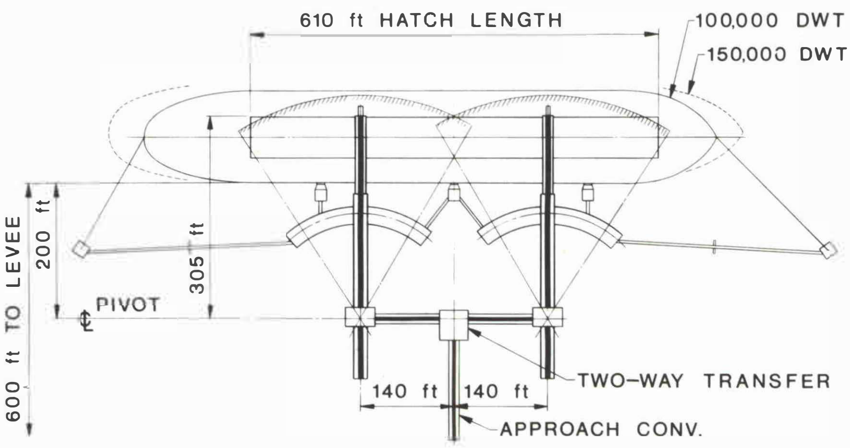

Fig. 5: 8,000 t/h Dual Radial Loader Plan

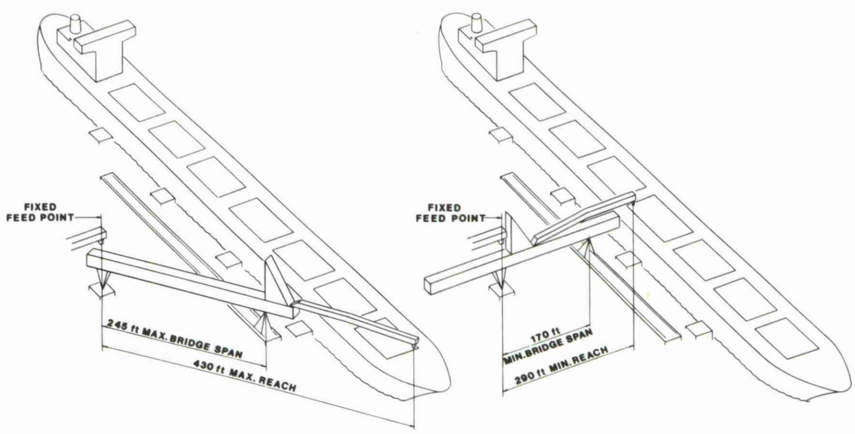

Fig. 6: Operating principle of Linear Loader

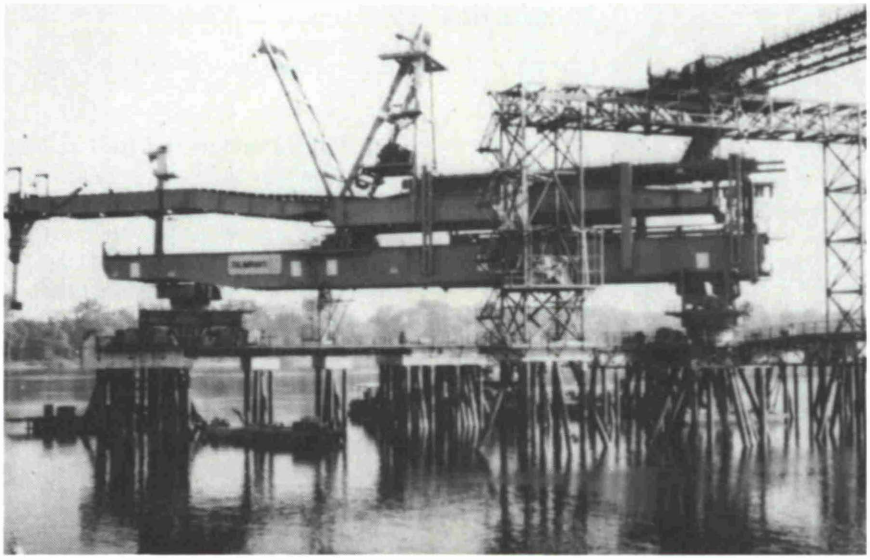

Fig. 7: 8,000 t/h Linear Loader of Soros design on Trombetas river, with 30 ft water level variation

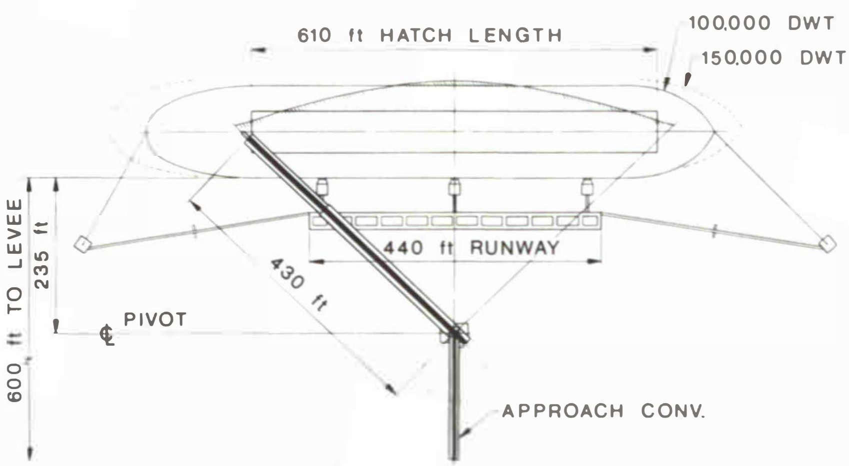

Fig. 8: 8,000 t/h Linear Loader Plan

Ranking:	Dual Radial	1
	Linear	2
	Traveling loader	3

7.2 Manpower Cost

Dual Radial requires 2 operators, the Traveling and Linear 1.

Ranking:	Linear	1
	Traveling loader	1
	Dual Radial	2

7.3 System Availability

The Linear has 2 elements subject to breakdown: approach conveyor, shiploader
The Traveling loader has 3: approach conveyor, dock conveyor, shiploader
The Dual Radial has 6: approach conveyor, two-way chute, 2 cross conveyors, 2 shiploaders

Ranking:	Linear	1
	Traveling loader	2
	Dual Radial	3

7.4 Power Consumption

The Linear has the shortest material flow, the least vertical drop at transfers and the best power factor. The Traveling loader has better power factor than the Dual Radial.

Ranking:	Linear	1
	Traveling loader	2
	Dual Radial	3

7.5 Mechanical and Electrical Maintenance

Linear has 1 transfer and 1 machine. Traveling loader has 2 transfers, 1 conveyor and 1 machine. Dual Radial has 3 transfers, 2 conveyors and 2 machines.

Ranking:	Linear	1
	Traveling loader	2
	Dual Radial	3

7.6 Marine and Structural Maintenance

Linear has 3 fenders and the least piles and structures. Dual Radial has 3 fenders with more piles and structures. Traveling loader has 6 fenders and the most piles and structures.

Ranking:	Linear	1
	Dual Radial	2
	Traveling loader	3

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7.7 Major Shutdown

The Dual Radial can continue to load small vessels with 1 cross conveyor, or 1 Radial Loader out of service.

The Dual Radial and the Linear have breasting dolphins independent of the marine foundations supporting the shiploader, offering better protection against marine accidents.

Ranking:		
	Dual Radial	1
	Linear	2
	Traveling	3

Table 6

	Linear Loader	Dual Radial	Traveling Loader
Capital cost	1	2	3
Production rate	2	1	3
Manpower	1	2	1
System availability	1	3	2
Power consumption	1	3	2
Mechanical and electrical maintenance	1	3	2
Marine and structural maintenance	1	2	3
Major shutdown	2	1	3
	10	17	19

8. Conclusion

The ranking in the various categories are summarized in Table 6.

The rankings only paint a general picture, as they do not establish the degree of preference in each category and the economic value of one category vs. another. For a detailed analysis, the cost of each item can be annualized and its present worth calculated to express it in terms of capital costs. Suffice it to say, that such an analysis will underline the economic value of utilizing the best available technology for the loading of large coal carriers on the Mississippi.

References

[1] Soros, P.: "Linear Loader Economics", Skillings' Mining Review, October 29, 1977

[2] Soros, P.: "High Capacity System for Bulk Materials Handling — 3,000 TPH Phosphate Terminal at Morehead City, North Carolina", Mineral Processing, July 1969

[3] Soros, P.: "Port Latta, Open Sea Loading Terminal", Civil Engineering, January 1969

[4] Soros, P.: "The Linear Loader", Skillings' Mining Review, March 5, 1977