TECHOLOGY DIGEST

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BRIDGE-MAINTENANCE ANALYSIS UNDER HEAVY-AXLE-LOAD TRAINS IN REVENUE SERVICE

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Summary

A study on Union Pacific's North Platte subdivision is beginning to show detrimental effects on bridge life and maintenance issues that can be directly attributed to the introduction of heavy-axle-load (HAL) trains. The Association of American Railroads initiated the HAL revenue-service program in 1992 to monitor the rate of introduction and the effects of HAL (286,000-pound gross rail load) traffic over revenue-service lines.

Although there has been no observed increase in bridge-maintenance expenditures in the past six years, the effects of the HAL traffic have begun to show in the types of maintenance work performed. However, these maintenance costs do not reflect capital expenses which could be HAL-related. Results from this ongoing study are as follows:

- Ground collar replacement as a result of bridge-pile pumping has become an area of focus in the past year.
- A significant amount of annual maintenance expenditures continue to be attributed to track-related items such as the installation of ballast retainers, and the raising of low approaches.
- Annual HAL traffic has increased to 38 percent of total traffic since its introduction in 1992.
- Bridge-maintenance expenditures have fluctuated slightly in the past six years.

Suggested Distribution:

- ❑ Bridges and Roadway
- ❑ Maintenance of Way
- ❑ Maintenance Planning
- ❑ Structures

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INTRODUCTION

A study of bridge life and maintenance issues on the Union Pacific's (UP) North Platte subdivision is beginning to show detrimental effects that can be directly related to the introduction of heavy-axle-load (HAL) traffic. This revenue-service study began to monitor the effects of heavy axle loads in 1992. Since that time, bridge-maintenance records provided by the UP have been analyzed to determine if there is a correlation between axle loads and maintenance expenditures (no capital expenses) on a line carrying unit coal traffic almost exclusively. The Association of American Railroads initiated the HAL revenue-service program to monitor the rate of introduction and the effects of HAL (286,000-pound gross rail load) traffic over revenue-service lines.

With the introduction of HAL cars, axle loads and average car weights have been steadily increasing with the rising percentage of overall HAL traffic. Traffic on this line prior to 1993 was almost entirely 263,000-pound cars that produced significantly lower wheel loads. Exhibit 1 shows that HAL traffic has increased from less than 0.5 percent of total traffic in 1992 to 38 percent in 1997. Both the total traffic and HAL traffic have increased since 1992 only to slow in growth over the past year.

Bridges on this line are categorized into three types: steel, timber, and concrete. The original 167-mile portion of the line constructed by UP around 1910 includes all three bridge material types, while an adjacent 107-mile segment of track added in 1983 and 1984 by UP's predecessor on this route, Chicago and North Western Railway Company, is composed only of ballasted-deck steel bridges.

The entire North Platte subdivision is composed of approximately 55 percent steel, 14 percent concrete, and 31 percent timber bridges with an average of about 40 feet of bridge per mile while the national average is much higher at 67 feet per mile.

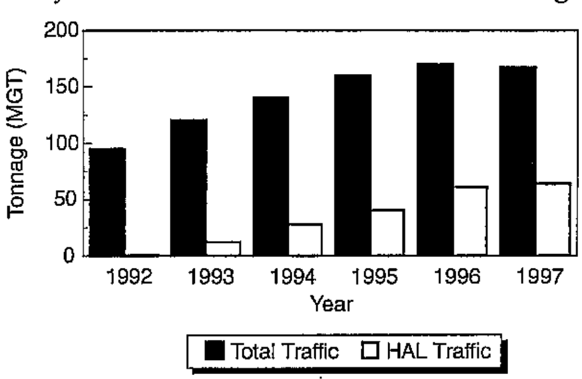

Exhibit 1. Annual HAL Tonnage

BRIDGE MAINTENANCE

Overall annual maintenance expenditures have fluctuated slightly in the past six years, but no definite trend is evident at this time. One contributing factor of stable costs may correspond to the UP taking a proactive approach on maintenance practices with the introduction of HAL traffic. However, these cost averages will be dramatically influenced with any significant maintenance cost in the future. This is to say that if a relatively large sum is required to remedy a specific situation, these cost averages will be greatly affected.

The annual maintenance expenditures per foot of bridge on this line is reflected in Exhibit 2. And, although a slight fluctuation is evident, there has been no increasing trend in total money spent over the past six years. As Exhibit 3 shows, there is more than a 20-percent decrease in average traffic-related costs over the past five years with respect to the traffic-related expenditures prior to 1993. Traffic-

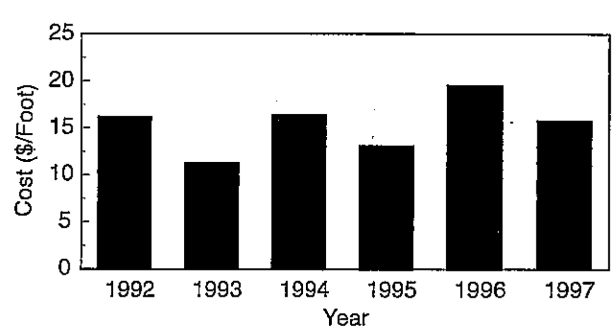

Exhibit 2. Annual Bridge-Maintenance Cost / Foot

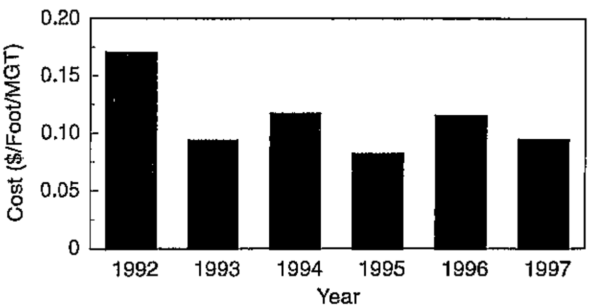

Exhibit 3. Annual Bridge-Maintenance Cost / Foot / Million Gross Ton (1910 and 1984 sections)

related costs are defined as money spent for maintenance issues resulting from traffic degradation only. Work such as the clearing of obstructed channels or the addition of rip-rap for scour protection is not included in this category. Capital costs related to total bridge replacement are also excluded from this study.

The average maintenance expenditure per foot is categorized by bridge type in Exhibit 4. Compared to last year's study (TD 97-017), maintenance expenditures for steel bridges have risen considerably. The UP has spent a considerable amount in the past year on replacement of ground collars to alleviate pumping of steel piles in trestle bents. The increase in pumping piles is likely due to the increase in HAL traffic in recent years over this line. Maintenance expenditures for timber and concrete bridges have not changed significantly compared to last year.

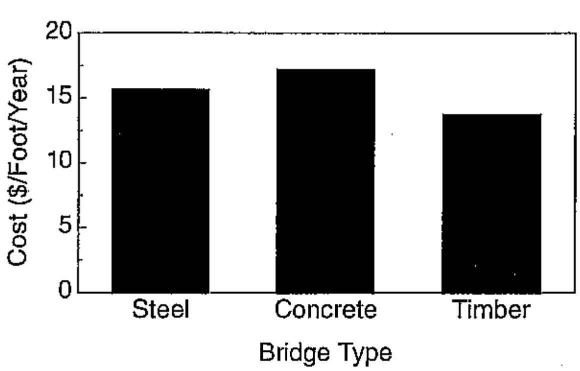

Exhibit 4. Bridge-Maintenance Cost by Category 1992 – 1997 (Original Line)

As Exhibit 5 shows, concrete repairs performed in 1995 were a significant factor in overall maintenance expenditures for concrete bridges. However, having spent no money on concrete bridge repairs in 1992 and 1997 did offset the large expenditure in 1995, and the average maintenance cost over the past six years is now dropping. Expenditures in 1997 also include the total replacement of two timber bridges. Both 42-foot-long bridge sections were replaced with culverts.

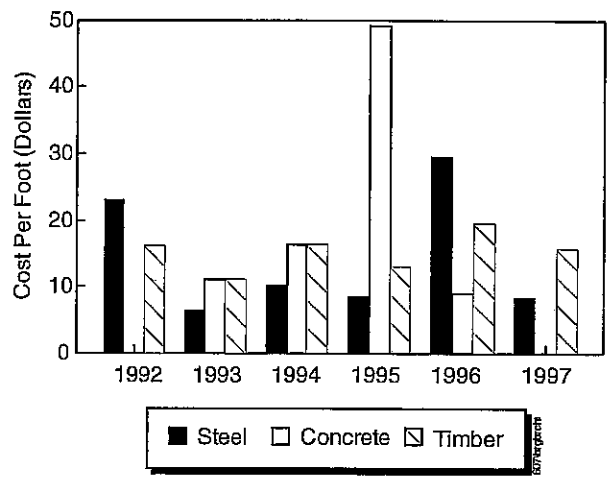

Exhibit 5. Annual Cost per Foot by Bridge Type

Exhibits 6, 7, and 8 show itemized costs for steel, concrete, and timber bridges. The highest maintenance expenditure for steel bridges is the rewelding of caps and beams along with the replacement of ground collars. The most

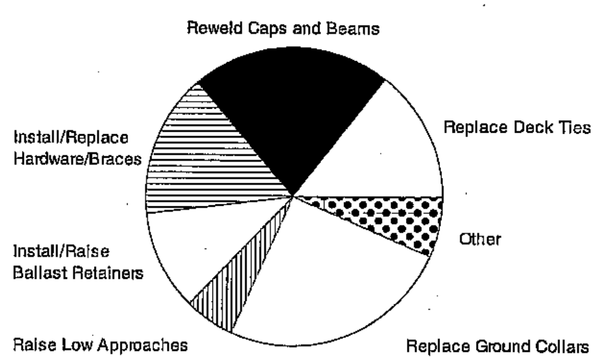

Exhibit 6. Steel Bridge Maintenance 1992 – 1997 (1910 and 1984 sections)

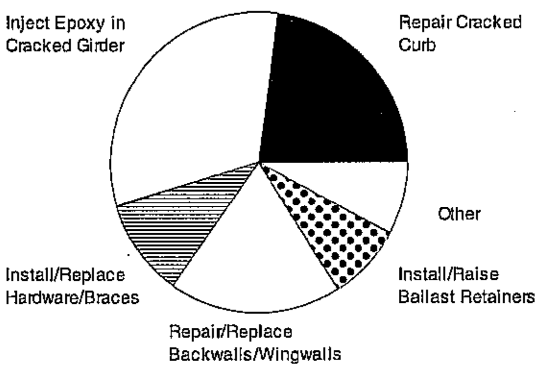

Exhibit 7. Concrete Bridge Maintenance 1992 – 1997 (1910 and 1984 sections)

money spent on concrete bridges was epoxy-injection repairs of a cracked girder. Also note that among all three types of bridges, a significant percentage of these costs are associated with track-related issues such as the installation of ballast retainers and the raising of low approaches. This maintenance may be categorized under track work for other rail lines.

The replacement of ground collars is a repair concern that has just surfaced within the past year, and shows a significant cost expenditure among steel bridges (Exhibit 5). This maintenance issue is a result of pile pumping and may become an area of future investigation depending on frequency and severity. It is very likely that this is related to the increase in HAL traffic in recent years.

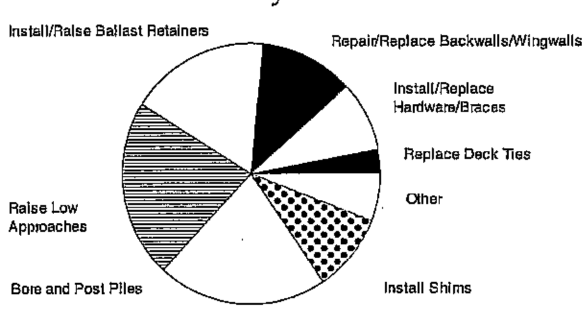

Exhibit 8. Timber Bridge Maintenance (1992 – 1997) (1910 and 1984 sections)

CONCLUSION

This study is still in its infancy with respect to the average bridge life on this line. Therefore, it is possible that there is significant fatigue damage occurring that has not yet become evident. It is also conceivable that we are observing a lull in the cyclic maintenance schedule. The North Platte subdivision was upgraded where required to accommodate HAL traffic. Fixed budgets and personnel availability could limit these costs as well.

The pile-pumping issue related to ground collar replacement is also a very significant finding. This maintenance topic may provide valuable information and insight in the near future if pile pumping continues.

Further investigation and monitoring is still advised to analyze expected bridge degradation due to HAL traffic since the results of this study are providing an informative guide for further analysis of bridge components in other revenue-service areas.

The findings in this study should not be generalized and are specific only to this line. Many results may vary dependent on bridge location, age, capacity, and maintenance policies of specific railroads.

ACKNOWLEDGMENT

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