TECHNOLOGY DIGEST

Timely Technology Transfer

"ECONOMIC COMPARISON OF CONVENTIONAL, CONTINUOUS ACTION, AND DESIGN LIFT TAMPING"

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TD 96-016

Summary

In a test performed by the Association of American Railroads, design lift tamping, which applies a measured overlift to the track to produce a more durable smoothing, was three times more durable than conventional tamping. In a further study, the most cost effective track surfacing technique was selected by analyzing the tradeoff between speed and durability of conventional tamping and two alternative methods—continuous action (CAT) and design lift tamping.

The railroad industry is currently achieving lower track surfacing costs by reducing the amount of production tamping in favor of tamping only those rough track sections needing geometry correction. To further lower costs, it appears more effective to perform this spot tamping with longer lived, rather than faster methods. CAT has a faster production rate, while the track smoothing provided by design lift tamping is the most durable.

To calculate the economics for each method, equipment, labor, and material costs were determined. Increased durability of the design lift process reduces tamping life cycle costs far more than the increased production rate provided by CAT. A break-even analysis is used to show how much can justifiably be spent modifying conventional tampers to provide design lifts.

Although design lift tamping appears to provide a much more durable track smoothing than conventional tamping, this is based on a rather limited number of tests. More tests under varied track conditions are desirable.

Suggested Distribution:

- ❑ Maintenance of Way
- ❑ Research and Development
- ❑ Maintenance Planning
- ❑ Track Maintenance

Association of American Railroads
Research and Test Department

June 1996

INTRODUCTION AND CONCLUSIONS

In a test performed by the Association of American Railroads (AAR) at the Transportation Technology Center (TTC), Pueblo, Colorado, design lift tamping was three times more durable than conventional tamping. The tradeoff between speed and durability was analyzed using life cycle cost comparisons of conventional tamping to two alternative methods - continuous action (CAT) and design lift tamping.

Design Lift Tamping

The design lift technique applies a measured over-lift to the track to compensate for the initial, rapid ballast settlement occurring with the onset of traffic just after maintenance. With further traffic, the track settles into the design smoothed profile as shown in Exhibit 1. This profile degrades slowly following the initial settlement because the ballast deformation rate typically decreases with loading cycles. In contrast, conventional tamping produces its best smoothing just after maintenance. The ensuing traffic often degrades the surface quality.

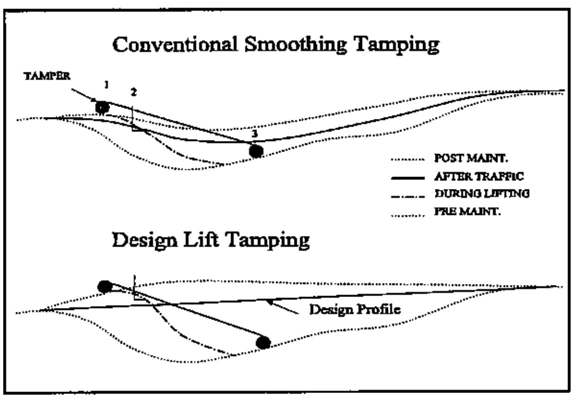

Exhibit 1. Conventional and Design Lift Tamping

A design lift tamping test was conducted by TTC on revenue track and compared to the performance of conventional tamping. A 200-foot section of track required conventional tamping every 3 months to maintain FRA Class 4 profile. The track did not require surfacing again until 9 months following the design lift—a three-fold increase in durability.

SPEED VERSUS DURABILITY

A Case Study Cost Comparison

Although tamping production rates are important, especially as available track maintenance time shrinks, the benefits of longer lasting results have not been sufficiently explored. The comparative benefits of both approaches are shown below.

As a case study, consider that for each continuous mile of track there is a 250-foot section requiring (conventional) spot tamping every 6 months. Exhibit 2 shows the assumptions used in the economic analysis for each tamping technique.

Exhibit 2. Initial Data Used in Analysis

	Conv.	CAT	Design Lift
Prod. Rate (ft/hr)	1200	5000	800
Equip. Cost ($/day)	$186	$697	$186
Ballast Req. (ton/mile)	20	20	30
Tamp Cycle	6 mos.	6 mos.	(See above)

The increased equipment cost for CAT is attributed to the purchase price, which is about four times higher than that of a conventional tamper. Although the cost of modifying a tamper to provide design lifts would increase its equipment cost over that of a conventional tamper, this same equipment cost is used for both methods. The analysis that follows then finds the amount which could be spent to modify an existing tamper to provide design lifts. More ballast material is assumed to be needed for design lift tamping than for conventional and CAT, since the former technique generally requires larger track raises. Finally, the tamping cycle is varied in the analysis between a doubling and a tripling of the duration over that of conventional tamping and CAT. This conservative approach is used because the factor of three increase in durability found in the TTC study may not be achieved in every case. (The study was conducted at one site.)

The travel time between sites, labor requirements and per hour costs, ballast material unit cost, and available track time were all constant for each tamping method. Considering the unit costs for labor, ballast, and equipment, the total per mile spot tamping costs are $227, $225, and $336 for conventional, CAT, and design lift tamping, as shown in Exhibit 3.

Exhibit 3. Unit Costs Used in Analysis

	Conv.	CAT	Design Lift
Prod. Labor Req. (hr/mile)	0.31	0.15	0.41
Tamping Prod (miles/shift)	19	40	14
Total Labor Cost ($/shift)	$320	$320	$320
Unit Labor Cost ($/mile)	$17	$8	$23
Unit Equip. Cost ($/mile)	$10	$17	$13
Ballast Cost ($/mile)	$200	$200	$300
Total Cost ($/mile)	**$227**	**$225**	**$336**

Despite the increased production capability of CAT, its total cost is only slightly lower than for the conventional. Because of higher equipment (purchase) costs, its greater productivity is also of little benefit when the tamping sections are short relative to the distances between them. The design lift total cost is higher due to its slower productivity and an increased ballast requirement.

Possible differences in train delay and associated costs between the tamping methods were considered. Because the allowable work time is constant regardless of machine productivity rate, any train delay and related costs incurred would be the same for each method.

COST TRADEOFF

The next step considers the recurring costs of spot maintenance with the three tamping techniques. Tamp cycle duration life cycle costing is used. Using a discounted cash flow analysis over a 7-year planning horizon (the life of a tamper) and a 10 percent annual cost of capital, the costs of tamping today and repeatedly in the future are converted to a Present Value (PV) per mile. As shown in Exhibit 4, the PV of CAT is only somewhat lower than conventional tamping. The cost reduction provided by design lift tamping depends on the amount of increase in tamp cycle duration. The cost analysis was performed assuming increased durations of 2, 2.5, and 3 times that provided by conventional and CAT.

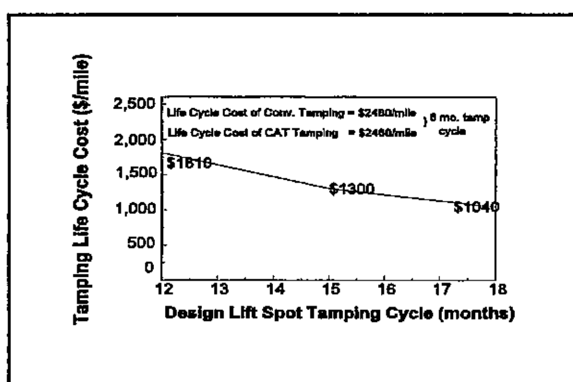

Exhibit 4. Seven Year Present Value Cost of Spot Tamping

If it is assumed that design lift provides, on average, a 2.5 tamp cycle increase (from 6 to 15 months), the PV cost per mile is $1300. The difference between this cost and that for conventional and CAT is used in a break-even analysis, where the choice is between conventional and design lift, and between CAT and design lift. To determine the cost savings over an entire railroad system, the PV cost for each method is multiplied by the total number of miles spot tamped by a railroad. The total miles tamped in one year is varied between 2500 (small road) and 20,000 (large road).

The present value of expense difference, or savings, provided by using design lift tamping over conventional tamping, during the 7-year horizon, is shown in Exhibit 5. Because the PV for CAT is virtually the same as for conventional tamping, the cost savings for changing from CAT to design lift tamping is practically the same. For a railroad with 10,000 miles, a savings of about $12 million over 7 years is expected using design lift tamping. This means that as much as $12 million could be justified to modify an existing fleet of tampers to provide design lift tamping. The actual savings to the railroad would be the cost of tamper modification deducted from the $12 million.

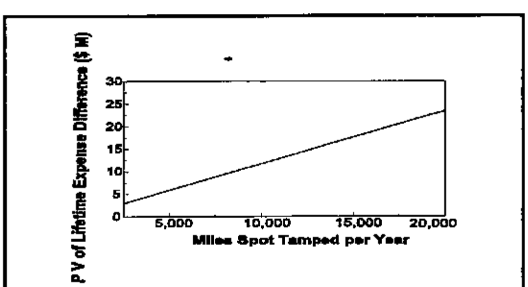

Exhibit 5. Savings from Design Lift Compared to Conventional Tamping

To actually achieve these cost savings with design lift tamping, there must be certainty that the problem is ballast-related and that the ballast condition will allow such stable raises. If an over-stressed subgrade is largely to blame for short tamping cycles, then no tamping method is likely to produce durable results. Similarly, if the ballast is fouled and wet, some other maintenance technique, such as ballast renewal, may be required.

In summary, though the design lift tamping method increases certain costs in the short term, there is a longer term benefit to be obtained by using this more durable technique. Early tests are very encouraging. More tests under more varied track conditions will help to further quantify the amount of benefit and the associated cost savings. It is recommended that further work be performed to:

- determine the most economical means of obtaining the pre-maintenance rough track profile,
- develop a number of track lift-settlement relationships for a variety of track conditions and climates so that track raises and design lift smoothing can be specified with confidence, and
- determine requirements of on-board computers to allow calculation of design curve and required tamper track raises (some tampers already have such computers).

Software which provides a smoothed design curve and calculates the required track lift heights is commercially available.

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A MORE DETAILED REPORT, WHICH MAY CONTAIN REVISED INFORMATION, MAY BE AVAILABLE AT A LATER DATE THROUGH THE AAR, PUBLICATION ORDER PROCESSING, 50 F STREET, NW, 5TH FLOOR, COG, WASHINGTON, D.C.,20001