

"DESIGN LIFT TAMPING"

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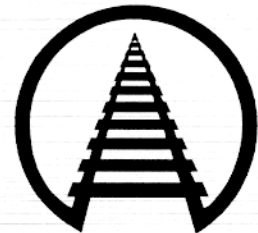
Summary

Field evidence suggests that design lift tamping can result in a three-fold increase in time between tamping cycles when compared to conventional tamping. Its increased durability was determined at the Transportation Technology Center (TTC) under heavy axle load (39-ton) traffic and in a revenue service test conducted on the Atchison, Topeka, and Santa Fe (AT&SF) Railroad. Design lift tamping can result in considerable savings by lowering maintenance costs and reducing tamper-induced ballast degradation.

The quality and durability of vertical track geometry produced by conventional tamping is limited by such factors as tamper "blind spots" to certain wavelength faults, insufficient track-lift heights, and the three- or four-point reference system which does not view the track as being continuous in space. In the design lift tamping process (with a conventional tamper), these limitations are eliminated because the lift is determined not with reference to a three- or four-point chord, but by the existing and desired continuous rail profiles. Further, to make the smoothing longer lasting, a predetermined amount of over-lift is applied to the designed, smoothed profile to allow for the initial, rapid settlement which occurs with the onset of traffic after tamping. Since ballast settlement following this initial amount is usually fairly small, the smoothed profile of the design over lifted track is more durable. On the other hand, the smoothing provided by conventional tamping often quickly degrades with the initial settlement within the first few MGT.

Suggested Distribution:

- Maintenance of Way
- Maintenance Planning
- Track Maintenance
- Research & Development



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INTRODUCTION AND CONCLUSIONS

Design lift tamping has been shown in testing to produce a three-fold increase in the length of tamping cycles compared to track tamped by conventional means. This can provide a significant savings due to reduced maintenance and less tamping induced ballast breakdown.

The increased durability of a smoothed profile provided by design lift tamping was largely due to:

- ▶ a smoothing design which "sees" the continuous shape of the track with its many fault lengths within and beyond the tamper frame of reference, rather than at a few discrete points, and
- ▶ the measured over-lifting applied to allow the track to obtain the design profile following the initial rapid ballast settlement after maintenance.

This allows for a more optimal smoothing than provided by conventional tamping. With each lift, conventional tamping corrects the track with reference to only three or four points along the track. Although an over-lift is sometimes used in conventional tamping, it is subject to operator and machine limitations.

OVER-LIFTING IN CONVENTIONAL TAMPING

Why not simply have the tamper apply an over-lift? The advantage of over-lifting to lengthen maintenance cycles is known and is sometimes attempted by skilled operators. However, even an experienced operator has difficulty producing smoothed profiles as shown in Exhibit 1. In this case, the operator was instructed to use his best judgement and "dial in" an over-lift to compensate for the larger dips over approximately 300 feet.

While a larger raise was provided in the areas with more severe dips, the smoothing was not optimum since too little lift was applied from about tie 20 to tie 50, and too much lift was applied from tie 60 to tie 120. This under- and over-compensating is to be expected given that operator skill is seldom sufficient to overcome the limitation of a tamper that can see only a few points along the rail profile, not "the whole picture."

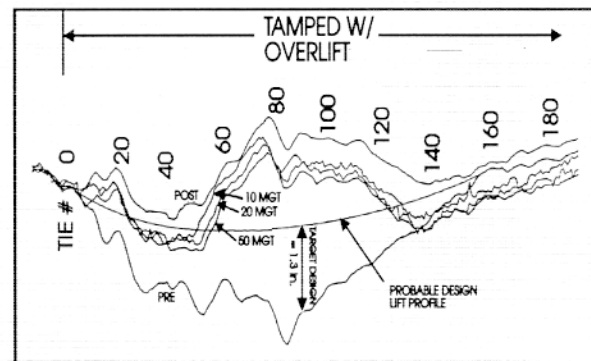


Exhibit 1. Attempting Over-lift with Conventional Tamping

A comparison between how conventional three-point and design lift tamping would smooth a track fault is shown in Exhibit 2. Note the effect of measured over-lifting and using a design profile in the latter case.

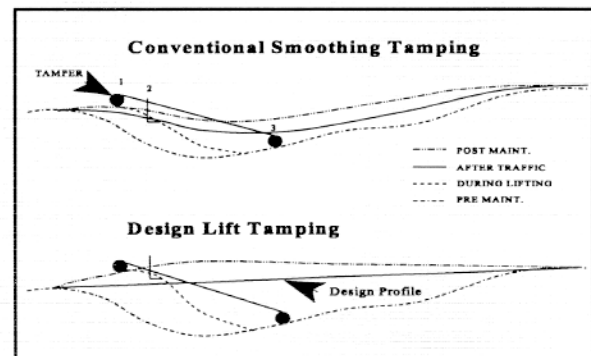


Exhibit 2. Conventional and Design Lift Tamping



RESIDUAL LIFT

The success of the design lift process depends on there being a predictable relationship between the applied and residual lifts as the track settles under loading. Applied lift is the change in rail elevation provided by the tamper. Residual lift is the remaining amount of track raise after a certain amount of tonnage. As shown in Exhibit 3, from actual field test data after 10 MGT, a reasonable trend between the two is indicated. Generic relationships between applied and residual lift are selected given the annual tonnage, subgrade type and modulus, and axle load. These relationships allow an engineer to specify lifts with assurance that the rail profile will be close to the design after so many MGT.

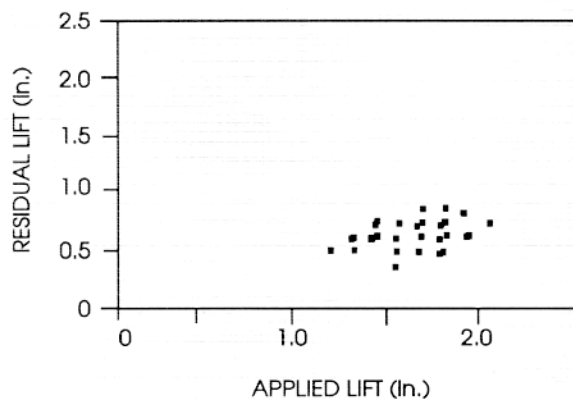


Exhibit 3. Relationship Between Applied and Residual Lift

The data shown in Exhibit 3 is for this field test case only. The exact relationship for a given situation will depend on the track characteristics and should be established from lift-settlement tests. Or, if no such measurements are to be made, it should be selected with care to be sure that the relationship applies for the track in question. The profile design program requires the top-of-rail longitudinal vertical geometry. This is obtained either by surveying or with a specially equipped tamper with software

which can generate this profile with a pass over the site. The design lift software program uses this pre-maintenance profile data and, with a certain specified over-lift, provides the lifts required to obtain the smoothed design profile.

TRACK TESTS OF DESIGN LIFT TAMPING

Before testing on revenue track, a design lift test was performed at TTC under 39,000 lb wheel loads (heavy axle loading, HAL). Test results provided a basis to conduct a test on revenue track. A section of track on the AT&SF railroad was chosen near TTC. This track required tamping every three months on average to maintain acceptable profile. A few top-of-rail surveys by TTC personnel confirmed the location of the problem site and the high rate of track settlement.

A pre-maintenance top-of-rail survey was performed and a design profile obtained with the design lift software program. The program also provided the amount of lift each tie should receive to attain a uniform over-lift above the design. Since the initial settlement tends to be fairly uniform with the onset of traffic, the track settled into the design profile and further settlement accumulated more slowly.

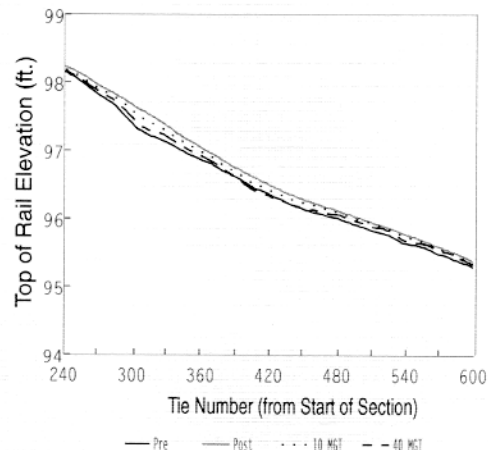


Exhibit 4. Design Tamp Test Top-of-Rail Profiles at Pre- and Post-Maintenance, and 10 and 40 MGT



Exhibit 4 shows the track profile of the east rail at pre- and post-maintenance, and with tonnage. The main problem area extended from Station 85 to Station 130, approximately 70 feet with a dip (at the time of the pre-maintenance survey) of 1.25 inches. Nine months (40 MGT) after the design lift, the track has almost returned to its pre-maintenance profile. Shortly after this last survey was made, AT&SF personnel decided to tamp the track, confirming that the tamping maintenance cycle was tripled.

This maintenance technique should not be used where an excessive amount of track settlement is due to a weak subgrade. The predictive ability of the residual lift relationship (Exhibit 3) is only valid where most of the settlement is within the ballast. Design lift tamping, or any form of tamping, should not be performed on track with short fault length problems such as bent rail or bad

welds. Research has shown that tamping will not correct faults with fault lengths below about 15 feet. Also it must be remembered that this process requires a measurement of the rail longitudinal profile before maintenance. This can be obtained by measuring the top-of-rail elevations with an optical survey, or a mechanized method which converts the slopes between wheels of a vehicle into relative changes in vertical rail head position.

A device has been developed to allow the tamper to measure the rail profile on one pass over the track. Then the onboard computer can be used with the design lift software to design a profile and specify the raises which are then applied on the second pass. This overall process takes more time than conventional tamping, but requires fewer tamping cycles. This is the cost tradeoff to be analyzed.

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