Lateral Track Stability: How Santa Fe Railway Achieves It Today

HERBERT G. WEBB

The Santa Fe Railway has been successful in controlling continuous welded rail thermal stresses that could lead to structural stability failures. The railroad's maintenance engineers take the company rules and guidelines seriously and follow them to the best of their ability. The railroad depends on the first-line supervisors to know the rules, know their territories in relation to possible thermal stresses in the rail, and to ensure that all who work on the welded rail follow the rules when the rail or ballast section is disturbed. Other contributing factors to Santa Fe's success are the adherence to territorial laying temperatures, anchor maintenance, ballast shoulder maintenance, scheduling of maintenance work, ballast compaction, slow order instructions, hot weather patrolling, management allowance of cutting of the rail, and train operation training and handling.

The focus of this paper is the success of the Santa Fe Railway in preventing lateral track stability failures. The author believes the subject to be important and believes that the practices of the Santa Fe might help other railroad maintenance engineers. Only 45 structural kink derailments occurred on the Santa Fe Railway from 1979 through 1988, an average of 4.5 per year. Of these, only 13 occurred on the main lines, and only 22 were on welded rail, an average of 2.2 per year. But even this small number is too many. Derailments are expensive losses for railroads and can have a detrimental effect on their profitability. The average cost per derailment has been $140,000, with one incident of $1.5 million (see Table 1).

Particular attention is paid to the following practices on the Santa Fe in order to achieve lateral track stability on welded rail.

1. Quality maintenance supervision,
2. Territorial target laying temperatures,
3. Anchor maintenance,
4. Ballast shoulder maintenance,
5. Maintenance operations,
6. Ballast compaction,
7. Slow orders,
8. Hot weather patrolling,
9. Cutting and welding, and
10. Train operations.

No one set of rules or guidelines fits the entire railroad system. The climate, track geometry, grade, train operations, and ballast conditions vary greatly from one division to the next and in some territories from one roadmaster to the next.

The Atchison, Topeka and Santa Fe Railway Company, 224 S. Michigan Ave., Chicago, Ill. 60604-2401.

The key personnel in maintaining lateral track stability are the first-line supervisors—the roadmasters or track supervisors. They must see that all rules are followed in their territories. They must ensure that maintenance procedures are followed by the foremen of all rail maintenance operations, from the initial laying of the rail to surfacing, curve relays, ballast maintenance, changing out single defective rails, and the multitude of other maintenance operations of the track section. First-line supervisors must ensure that all who work on the track structure understand what precautions must be taken to protect the delicate status of lateral track stability.

QUALITY MAINTENANCE SUPERVISION

The track structure supervisors—the people responsible for all maintenance performed on the track structure—must be fully knowledgeable of all company rules, instructions, guidelines, and territorial conditions that may affect the lateral stability of the track. They must pass this experience and knowledge to all foremen in the territory to ensure that they understand all precautions to be taken.

The supervisors must understand train operations in relation to slow orders that they or their staff may place in relation to the geometry of the track. It is important to know where there is "tight" rail and where maintenance work was done in cool or cold weather. They must be able to recognize unstable sections of track and must have management's authority and commitment to cut the rail when it is necessary to relieve excess thermal stresses.

TERRITORIAL TARGET LAYING TEMPERATURES

On the Santa Fe Railroad, a chief engineer's standard designates welded rail laying target temperatures for each subdivision in the entire system (Figure 1). These rail laying temperatures are strictly adhered to during rail relay operations. Rail heaters are used to ensure that the rail has been properly expanded or elongated in order to achieve an operational neutral rail temperature for the geographical area. It is very important, and is stressed to the rail laying supervisor, that the rail must be expanded or elongated, not just heated. Records are kept on the rail relay to ensure that the rail was laid at the designated temperature. The rail is spiked and anchored as quickly as possible behind the small, portable heaters used on curve relay gangs and other rail replacement operations.

TABLE 1 DERAILMENT STATISTICS

YEAR	MAINLINE CWR	MAINLINE JT	NON-MAINLINE CWR	NON-MAINLINE JT	TOTAL
1979	0	0	0	3	3
1980	4	0	7	2	13
1981	2	1	0	4	7
1982	0	0	2	1	3
1983	1	0	2	2	5
1984	0	0	0	2	2
1985	0	0	0	4	4
1986	1	0	1	1	3
1987	0	0	0	0	0
1988	1	1	1	2	5
Total 10 Years	9	2	13	21	45

ANCHOR MAINTENANCE

Every other tie on welded rail is box anchored. Anchor squeezing applicators are used to ensure that the anchors are tight against the tie. All ties in turnouts to which the applicators can be physically applied are fully box anchored. Sixty ties in both directions from all track joints in welded rail territory are also fully anchored.

In all major maintenance operations, such as mechanized tie renewal or ballast undercutter cleaner programs, missing or lost anchors are replaced. Anchor squeezers are used on major surfacing projects to ensure that the anchors are tight. Automatic squeeze tamping operations tend to move the crossties tightly against the anchors on one side, thus leaving the other two anchors ineffective. Anchor maintenance is an important part of maintaining lateral track stability.

BALLAST SHOULDER MAINTENANCE

The Santa Fe Railway ballast shoulder standard is somewhat less than that of many major railroads—6 in. on tangent track and 12 in. on the high side of curves of 2 degrees and more (Figure 2).

Determining the amount of necessary ballast shoulder is always a difficult decision for the maintenance engineer. A good solidified ballast section assists in lateral stability, whereas too much ballast prevents good drainage.

MAINTENANCE OPERATIONS

A number of precautions are taken on the Santa Fe Railway to preserve lateral stability during track maintenance operations. Every effort is made to perform maintenance at a temperature at which the lateral track stability will be least disturbed. In many cases this effort is not successful because of the size of the railroad and the economics of gang scheduling.

Maintenance personnel try to recognize areas of tight rail. In some cases local division supervisors will cut the rail and let it run before the programmed maintenance operation. Many times a welder is placed with a tie gang or ballast cleaning operation as an added precaution so that if tight rail is found, it can be cut and welded immediately. A disturbed track slow order is also placed.

Another company rule is never to add rail when cutting in or replacing a rail for any reason. The rail section is not tightened in such operations as lining in curves or making large surfacing raises through short sags in the grade. If these operations must be accomplished, welders are available to cut and weld.

BALLAST COMPACTION

Ballast crib and shoulder compactors are used behind all major surfacing operations. This compaction provides the approximate equivalent of 3 or 4 days of train operation in restoring lateral stability of the track. The slow order can be removed much sooner and in many cases does not need to be placed at all. The compaction replaces a good portion of the lateral track stability that existed before the maintenance operation.

SLOW ORDERS

The following slow orders are placed on all disturbed track when the ambient temperature is 80°F or higher or when the rail temperature is above the adjusted rail laying temperature.

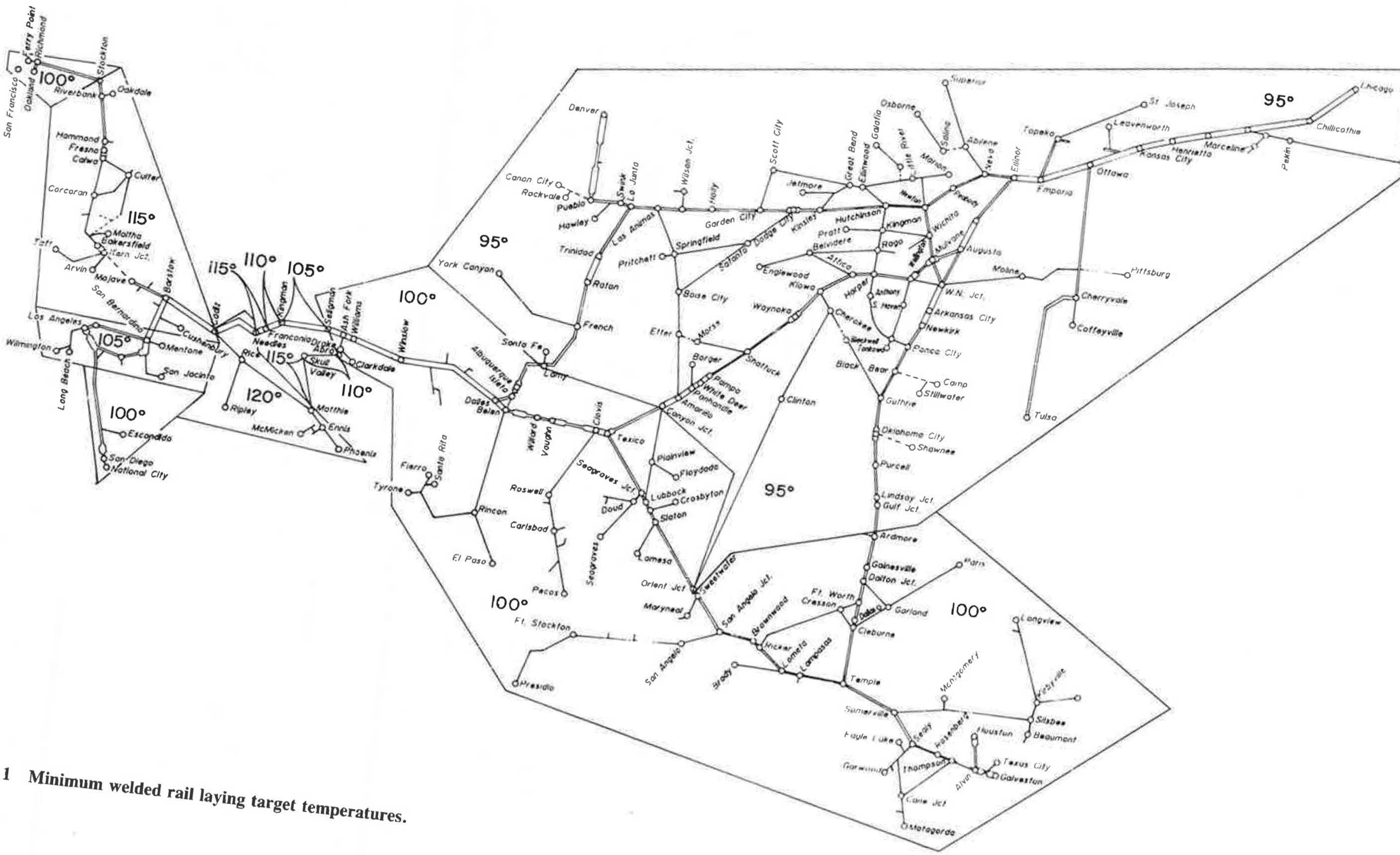
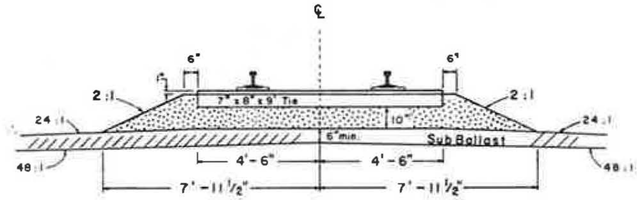
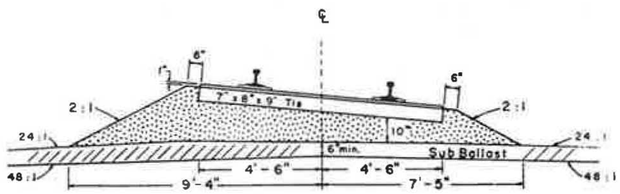


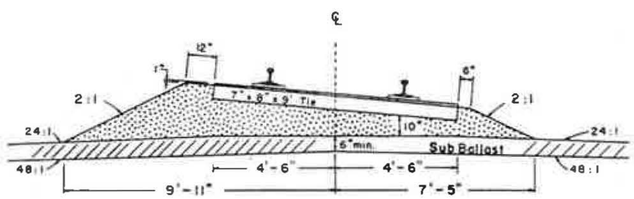
FIGURE 1 Minimum welded rail laying target temperatures.



Single Track Tangent



Single Track Curves Less Than 2°, 5" Super Elev. (max.)



Single Track Curves, 2° an over, 5" Super Elev. (max.)

SINGLE TRACK

	℄ of Track to toe of slope of ballast		Cubic yards per mile
Tangent Track	7'-11 1/2"		3487
	OUTSIDE	INSIDE	
Track Curves Less Than 2°	9'-4"	7'-5"	4321
Track Curves Greater Than Or Equal To 2°	9'-11"	7'-5"	4600

NOTES

1.-Top of ballast shall be finished 1" (inch) below top of tie where applicable.

2-Yardage of ballast shown on this sheet has been computed on the basis of 3250 sawn cross ties, 7"x8"x9', per single track mile. An allowance of 15 % for shrinkage is included.

3-For sections on curves the distance from centerline of track to toe of slope of ballast is computed for superelevations of 5" (inches). This distance will vary with each amount of superelevation, and must be computed in each case.

4-Ballast quantities for sections on curves are computed for superelevations of 5" (inches) and shall also be used for all curves with less than 5" (inches) of superelevation.

5-Chief Engineer's authority must be obtained before using a ballast section other than the 10" (inch) section shown.

6.-Refer to C. E. NO 5670, sheet 1 of 2, for cross tie length and assignment.

FIGURE 2 Ballast shoulder standard.

- On main track with 30 million gross tons (MGT) or more, a speed limit of no more than 30 mph should be placed for at least 24 hr.
- On main track with 20 to 30 MGT, a speed limit of no more than 30 mph should be placed for at least 48 hr.
- On main track with 20 MGT or less, a speed limit of no more than 30 MPH should be placed for at least 72 hr.

Disturbed track is the result of any maintenance operation that causes the rail to be cut or any operation that disturbs the ballast section. A roadmaster or designated local maintenance officer has the freedom to place a slow order at any location that does not have the lateral stability necessary for full train operations. If the ballast section is not standard or if the track raised was not fully compacted or stabilized, additional orders might be placed.

When it is necessary to perform maintenance that disturbs the track under an ambient temperature below 80°F or a rail temperature below the adjusted rail laying temperature, the foreman of the gang that completes the work must check the crosslevel and alignment of the disturbed track and place a speed restriction, if necessary, to provide for the safe operation of trains and engines.

Before the release of a slow order, the roadmaster or his designated representative must inspect the track even if the prescribed time period required in the disturbed track order has elapsed.

When a ballast compactor is used in conjunction with a surfacing operation, and inspection by the foreman indicates that standard ballast section, alignment, and surface are proper, it is not necessary to place any of the above speed limits.

It is important to recognize track geometry locations where care must be taken in placing orders. The supervisor must understand train operations and dynamic brake applications to ensure that an order is not placed at a location at which it is impossible for the train engineer to comply without causing large stresses in the track.

HOT WEATHER PATROLLING

The roadmaster, assistant division manager of maintenance, or the assistant superintendent of maintenance decides during certain times of the year to perform hot weather patrolling. The decision depends on their knowledge of the railroad and the climatic conditions of that territorial location. It must be recognized when these prolonged hot periods are a definite danger to the lateral stability of the track. Seven-day patrolling is initiated on the railroad during these conditions, and particular attention is paid to the track in the late afternoon hot periods.

Another hot weather tool used on the Santa Fe Railway is running branch line grain trains and sometimes normal freight trains at night whenever possible. These nighttime operations are mostly on branch lines on which ballast or maintenance problems are known to exist.

CUTTING AND WELDING

One of the typical phrases that can be heard by Santa Fe maintenance supervisors is, "When in doubt, cut, cut, cut." It may sound strange or even funny, but it is important to the lateral stability of welded rail. First-line field supervisors have the freedom and the responsibility to decide where and when to cut welded rail in order to relieve thermal stresses that the supervisor believes pose a threat to lateral track stability. The newly cut joint must be replaced with a field weld as soon as possible. Track joints should not exist in welded rail.

TRAIN OPERATIONS

An important consideration that tends to be forgotten is the effect on lateral stability of train operations. With the advent of dynamic braking, where 4,000- to 8,000-ton trains are being braked at the front end of the train, large lateral forces at rather short concentrated areas are exerted on the track structure. In many cases these forces occur at weak sections of track next to road crossings, turnouts, or other locations that maintenance engineers are trying to protect. The Santa Fe Railway has established an educational program on train handling for train engineers. The program covers such topics as the forces placed on track when dynamic brakes are used. In addition, the assistant division managers of maintenance take the engineer training program. A result of this training has been a better understanding of what the engineer can or cannot do when he approaches a slow order situation in relation to the handling of air or dynamic brakes and the geometry of the track.

The education of all concerned in the proper use of dynamic brakes has been a big help in controlling structural kink derailments and maintenance problems on the Santa Fe Railway.

SUMMARY

In summary, maintenance engineers on the Santa Fe Railway try to follow the established rules for maintaining lateral track stability of welded rail. A great deal of responsibility is given to the first-line supervisors to establish, preserve, and protect lateral track stability of continuous welded rail. The supervisors are given the rules, guidelines, instructions, and tools needed to accomplish this task, but it is still up to them and their foremen to actually perform all maintenance operations within those instructions and guidelines.

Maintenance engineers are rather proud of the railway's record in preventing structural kink derailments over the last few years. However, thermal stresses in welded rail are fickle. It seems that the forces on the trackage keep changing, which makes the job of maintaining the lateral track stability of that trackage an ever-changing one. Better methods, rules, equipment, and procedures must continually be developed to assist the first-line maintenance supervisors in their job of maintaining that lateral stability.