Framework for Short-Line Railroad Track Asset Management and Condition Reporting

Michael N. Grussing[1], and Donald R.Uzarski, Ph.D., P.E. [2],

1. Research Civil Engineer, Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL), P.O. Box 9005, Champaign, IL 61826-9005, 217-398-5307; Michael.n.grussing@erdc.usace.army.mil

2. Uzarski Engineering, 2011 Barberry Circle, Champaign, IL 61821, 217-398-3984; d.uzarski@insightbb.com

ABSTRACT

Many military, short line and low-volume industrial railroad networks require a unique infrastructure management approach that differs from commercial Class I and most regional railroads due to their size and operational characteristics. However, this does not eliminate the need for condition assessment, maintenance and repair, and capital planning. An Engineered Management System, RAILER® EMS, has been developed by the U.S. Army Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL) as a decision support toolbox for managing these rail assets and reporting infrastructure condition and readiness. This approach includes 1) categorizing the rail assets and attribute inventory information; 2) providing a standardized inspection process for identifying defects; 3) reporting operating restrictions; and 4) objectively quantifying track condition. The results of this process are then used to develop recommended short- and long-term corrective repair and capital renewal strategies. This paper discusses the RAILER® EMS process and framework for real-time objective condition and readiness reporting for military, short line, and industrial rail infrastructure, citing an implementation case study at a military installation.

BACKGROUND

With the recent rapid increase in rail transport volume and car weights and impending maintenance and capacity issues, attention has been brought to railroad infrastructure asset management and capital planning. While Class I and some regional line haul railroads have developed their own business processes, military, short line, and other low-volume railroad networks require a unique infrastructure management approach due to their size and operational characteristics. On these smaller networks, train speeds and traffic are usually lower, track assets may be geographically fragmented, and the use of production-scale inspection equipment, such as automated track geometry vehicles, is often cost prohibitive or impractical. As a result, the management practices of these low-speed, low-volume networks often involve reactive maintenance and repair, correcting deficiencies that adversely affect near-term operations as they arise. Experience has shown that this practice has a long-term adverse impact on the track network, due to compounding deterioration from repeated wheel loads and deferred maintenance and repairs on all but the most critical deficiencies. This highlights the importance of and need for a standardized, robust, and meaningful condition assessment metric to support a more proactive repair and capital renewal planning strategy.

For example, the U.S. military owns and operates thousands of miles of track which puts its scale on par with a small Class 1 or major regional railroad. However, this track is spread across installations worldwide, with each installation's network operating relatively independently akin to a short line or industrial network. This track is of strategic importance to the movement of equipment, munitions, and supplies, and requires a consistent inspection and condition assessment process to ensure that mission requirements can be met for each local network in a cost efficient manner.

Although railroad track networks represent an important infrastructure asset to support military transportation operations, they sometimes experience extended periods of disuse until an event warrants mobilization of military assets. Since track infrastructure competes for funding with other type of civil infrastructure at a military installation, track may undergo long periods of little or no sustainment and capital renewal expenditures. This policy results in potential catastrophic network failures when the rail system experiences a surge in use. To maintain readiness, military railroad track undergoes periodic safety inspections to identify critical defects that could cause a derailment. The frequency of these safety inspections is weekly, monthly, or semi-annually based on the use of the track (TM5-628, 1991). Because these inspections address only critical and catastrophic issues, they do not provide the rigorous basis for determining and reporting a comprehensive track condition measure or repair and capital renewal needs. To accomplish that, a more detailed track inspection is required. This detailed inspection is less frequent then a safety inspection and is sometimes performed in conjunction with planning rehabilitation work. To serve asset management needs, this detailed inspection should result in consistent metrics to monitor condition and performance.

RAILER EMS PROCESS

The RAILER® methodology is a standardized best-practice management approach for improved assessment and reporting of low-volume, low-speed (i.e., military, short line, and industrial) rail infrastructure condition and readiness. As a member of the Engineered Management System (EMS) family of products that includes PAVER, ROOFER, AND BUILDER, it provides information and support to engineers, facility planners, and policy makers in managing rail infrastructure on a network basis (ERDC-CERL, 2006). This approach includes 1) categorizing the rail assets and organizing attribute information about the track network; 2) providing a standardized detailed inspection process for identifying, classifying, and recording component defects and deficiencies; 3) reporting operating restrictions imposed by governing track standards due to present defects; and 4) using the inspection defect information to objectively quantify track condition. All of this information is then used in a systematic method to develop recommended short- and long-term corrective repair and capital renewal strategies.

Based on the most recent track inspection, the system reports condition, operating restrictions, and needed repairs using both tabular reporting and GIS features.

INVENTORY AND INSPECTION IMPLEMENTATION PROCEDURES

The inventory process defines the track assets to be assessed and managed. Key to this process is the division of the network into logical areas, tracks, and track segments. A track segment is the fundamental management unit in RAILER. One or more segments comprise a track, the name and extent of which are usually designated by previously established local conventions. Areas combine tracks of a similar use, and the overall network encompasses all tracks and areas at a site. In addition to defining this network hierarchy, attribute information about the track layout, structure, and key components is recorded. This information, which includes geometry, track structure, drainage, etc., plays a role in maintenance, repair, and renewal decisions.

Once the track inventory is defined and a reference system is established to locate items along the track, a standardized inspection process is completed to observe, identify, and record defects present in the track structure. This inspection process consists of identifying and recording defects associated with the track subgrade, ballast, geometry, ties, rails, turnouts, grade crossings, and other track materials such as fastenings, joint bars, etc. Associated with each recorded defect is the quantity or density affecting the track, along with the defect location. Inspection results are entered in a remote entry database program and stored in an electronic format (Uzarski, et. al., 2004). This program also displays inspection results from the previous inspection for verification as currently existing or fixed. As a consequence, the inspection process is consistent and repeatable, and inspection data are easily retrievable.

CONDITION ASSESSMENT

Using the collected inspection information, RAILER automatically links each defect to: 1) operation or speed restrictions based on the governing track standard*, 2) condition index metrics, and 3) a local work action to correct or repair the defect. Through this process, one inspection feeds three separate reporting requirements.

Governing track standards limit or restrict train movements over track segments that contain defects of a potentially catastrophic nature. When these defects are identified, the risk of a derailment is mitigated by limiting train speeds or restricting operations completely, and the program denotes the location of these defects accordingly. This serves the purpose of managing the short-term repair requirements of the railroad. These requirements mandate that the network or important corridors of operation be without restrictions at any point in time to support mission readiness or avoid revenue loss from delayed shipments.

Track condition is quantified through the Track Structure Condition Index (TSCI) metric (Uzarski, 1993). The TSCI represents the physical condition of the track on an

* Federal Railway Administration (FRA) standard or DoD Unified Facilities Criteria (UFC)

absolute 0-100 scale, with 100 being a segment of track completely free of defects. The TSCI is based on an aggregation of separate metrics for the ballast and subgrade (BSCI), ties (TCI), and rail, joints, and fastenings (RJCI). The TSCI is computed for each individual track segment and is rolled-up for an overall track, area, or network using a weighted average approach based on the track length of each segment.

The TSCI, and its constitutive component CIs, are best used as a performance metric to gauge the health of the track and the overall state of the capital investment. The metric information can alert track managers to potential problem areas of track before critical safety defects occur which affect short term operations. Most importantly, it serves as a key indicator to monitor the long term performance of the network, and is an objective and repeatable measure of condition for upward reporting.

MAINTENANCE AND REPAIR (M&R) PLANNING

The information collected during the inspection and compiled during the condition assessment phase directly supports the work plan development processes. Each defect type is associated with a localized work action to correct, along with a unit cost to perform the work. Since each defect is also linked to an operations restriction level, this relationship provides a quick prioritization of the most critical defects (no operations or restricted operations defects being a high-priority repair). This establishes the list of requirements to sustain operations in the near term.

However, an effective maintenance and repair strategy should also plan for the sustainment of the long-term track performance. A track maintained in very good condition should have very few critical defects to address, although some may still arise due to random occurrences. But if non-critical work on a track is deferred, track deterioration accelerates and the number of critical issues can increase dramatically. For example, poor drainage issues can lead to premature cross-tie decay and track geometry deviations, which in turn results in higher impact loads and increased rail section deflections. These conditions can spawn critical failures in the rails and joints. Correcting only these critical safety issues will result in only short-term improvements. However, the use of the condition index metrics would likely alert work planners to an impending problem before critical safety issues even arose. As a result, using the TSCI series as a performance metric can direct resources toward the best long-term solutions.

Therefore, in addition to high-priority critical work items, the total list of non-critical corrective work actions is further prioritized based on track usage, segment importance, and segment TSCI. In addition, the CI's provide a justification and flag track segments that may require more global restoration, renewal, or reconstruction efforts versus corrective repair sustainment work. For example, a TSCI above 80 would warrant spot repairs. Conversely, for a TSCI in the 60s or below, renewal of one or more of the major track components (rail, ties, and/or ballast) would likely be more efficient than correcting a large number of localized defects

CASE STUDY

The Fort Campbell railroad track network consists of 40 track-miles that serve force projections efforts and training activities (IMA, 2005). After the Vietnam War and up to the late 1980s, deferred track maintenance caused the rail network to deteriorate to a sub-standard state to efficiently support a mobilization mission. As a consequence, millions were invested to recapitalize the network. The RAILER system was implemented in the late 1990s as an asset management tool to efficiently maintain that performance and ensure future readiness.

Annual track inspections are performed at Ft. Campbell to support the RAILER condition assessment and M&R analysis. By factoring in critical restrictions, segment importance based on operations, and long-term CI targets, a prioritized annual M&R plan is developed. This plan lists track defects, the associated repair work action, cost to fix, and contract line item number, ultimately specifying the scope of work. In addition, by closely coupling condition reporting with the work requirements generation, RAILER provides a justifiable budget that better communicates requests for M&R resources. The DoD has developed models based on various commercial railroad data that estimates annual sustainment requirements at $16,088 per track mile. However, based on budget constraints, the rail infrastructure typically sees only a percentage of this estimate. Over the course of eight years of RAILER usage at Fort Campbell, improved work requirements identification has helped railroad annual sustainment funding to increase from 20% to 75% of that estimate, with the track structure condition index improving from 88 to 93. This was possible, even with less than full sustainment, because the M&R resources were allocated to track work that had the most beneficial impact on long-term condition and the TSCI index, while still providing for short-term operational constraints.

CONCLUSIONS

The RAILER process is an improved approach to low-speed, low-volume railroad track asset management when compared to safety inspections and reactionary critical repairs alone. A consistent and objective TSCI metric supports both condition reporting and repair/renewal decisions. This is shown to improve the allocation of sustainment resources to realize long-term performance improvements for the network, even under tight funding constraints. Although the focus of this report is on military network applications, the technology has been applied successfully within the civilian short line sector as well, due to its value as a low-volume track asset management tool.

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