Identifying the Sources of Ballast Fouling

While the existence of ballast fouling and associated symptoms of mud pumping and degradation of the track geometry are well known to maintenance-of-way personnel, the origin and nature of such fouling has long been a subject of debate and discussion. In order to focus-in on the nature of fouled ballast, an AAR-sponsored research project examined more than 30 fouled-ballast sites in North America (1, 2). These sites were chosen to provide a wide range of ballast types, soil conditions, climatic conditions and traffic. More than half of the sites showed mud at the surface of the ballast.

By carefully studying samples taken from the ballast, subballast and subgrade areas of these sites, researchers were able to focus on the different mechanisms and causes of the observed ballast fouling. Earlier studies (See *RT&S,* August 1988, p. 15) had identified three major categories of ballast fouling: Fouling from the surface, fouling from below the ballast layer and fouling from a breakdown of the ballast particles themselves. In this study, five ballast-fouling categories were identified:

—Ballast breakdown.
—Surface infiltration.
—Tie wear.
—Infiltration from the underlying granular (subballast) layer.
—Subgrade infiltration.

These mechanisms, which are illustrated in Figure 1, represent a range of causes that are commonly seen in the railroad environment. In the case of ballast breakdown, traffic loading and environmental conditions (such as freeze-thaw and other weathering effects) are important factors. Other factors include tamping, handling (particularly during shipping and placing of the ballast) and particle migration. In the case of surface infiltration, fouling material dropped from cars or carried by the wind or rain represent a potential source of fouling of the ballast. Degradation and wear of wood crossties represents a third source of fouling material. All of these mechanisms can be present even in a well-maintained roadbed with good drainage and a stable subgrade (1).

The remaining ballast-fouling mechanisms are associated with fouling originating beneath the ballast layer, either from the subballast (or layer of granular material below the ballast in the area where the subballast should be) or from the underlying subgrade material itself. These latter mechanisms are more commonly associated with poor or inadequate drainage (the presence of water) and/or the lack of a proper filter-separator to maintain separation of the underlaying materials from the ballast.

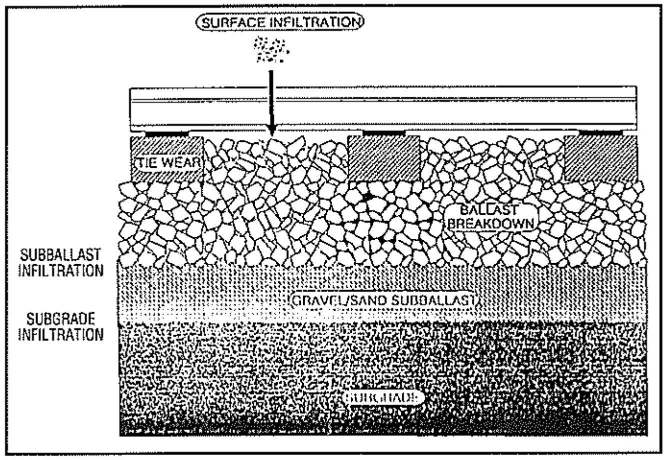

Figure 1 — Ballast-fouling mechanisms

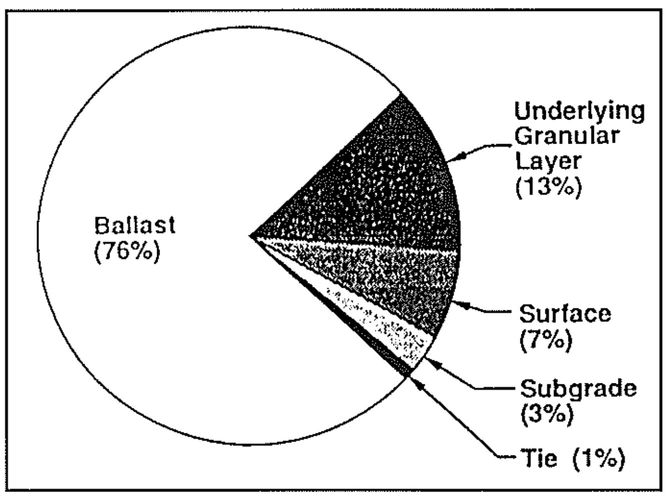

Figure 2 — Sources of ballast fouling for all sites combined (1).

Ballast breakdown

The results of the investigation, which examined the sources of the fouling through careful examination of the ballast materials, are presented in Figure 2. As can be seen in this Figure, ballast breakdown was, by far, the most important source of fouling, with 76% of the fouling particles coming from the ballast itself (1). The second most common source (significantly less than from ballast breakdown) was infiltration from the underlying granular layer (subballast) with 13% of the fouling. Surface infiltration was the next source, with 7% of the fouling particles. It was noted, that while surface infiltration was often observed, it was generally a minor source of fouling. The last two potential sources, subgrade infiltration and tie wear, were reported to be relatively insignificant, with only 3% and 1% of the fouling particles, respectively.

While most sites reported the presence of more than one fouling source, the predominant source of the fouling was found to be ballast breakdown (with the exact mix depending on site-specific conditions). This behavior is illustrated in Figure 3, which shows the composition and breakdown of ballast and subballast layers for one specific mud pumping site. As can be seen in this Figure, only half of the ballast sample was actually composed primarily of properly-sized (greater than 3/8-inch) ballast particles. The remainder of the ballast sample was composed of ballast broken down into coarse fouling components (3/8-inch to No. 200 in size) and fine fouling components (less than No. 200 in size). Although some rounded quartz subballast particles, wood tie particles and coal and cinders from surface infiltration were found, they constituted less than 15% of the total ballast sample.

A similar effect can be observed within the subballast sample, with more than 85% of the subballast sample consisting of the rounded quartz subballast material itself. Fouling from coal and cinder infiltration, ballast (syenite) and wood ties comprised the remainder of the sample.

While exceptions to these results will certainly be found, it appears that ballast particle breakdown represents a dominant cause of ballast fouling under a broad range of traffic and environmental conditions. This suggests that the use of a high-quality, degradation-resistant ballast may be an effective technique to reduce or avoid ballast fouling under heavy traffic conditions.

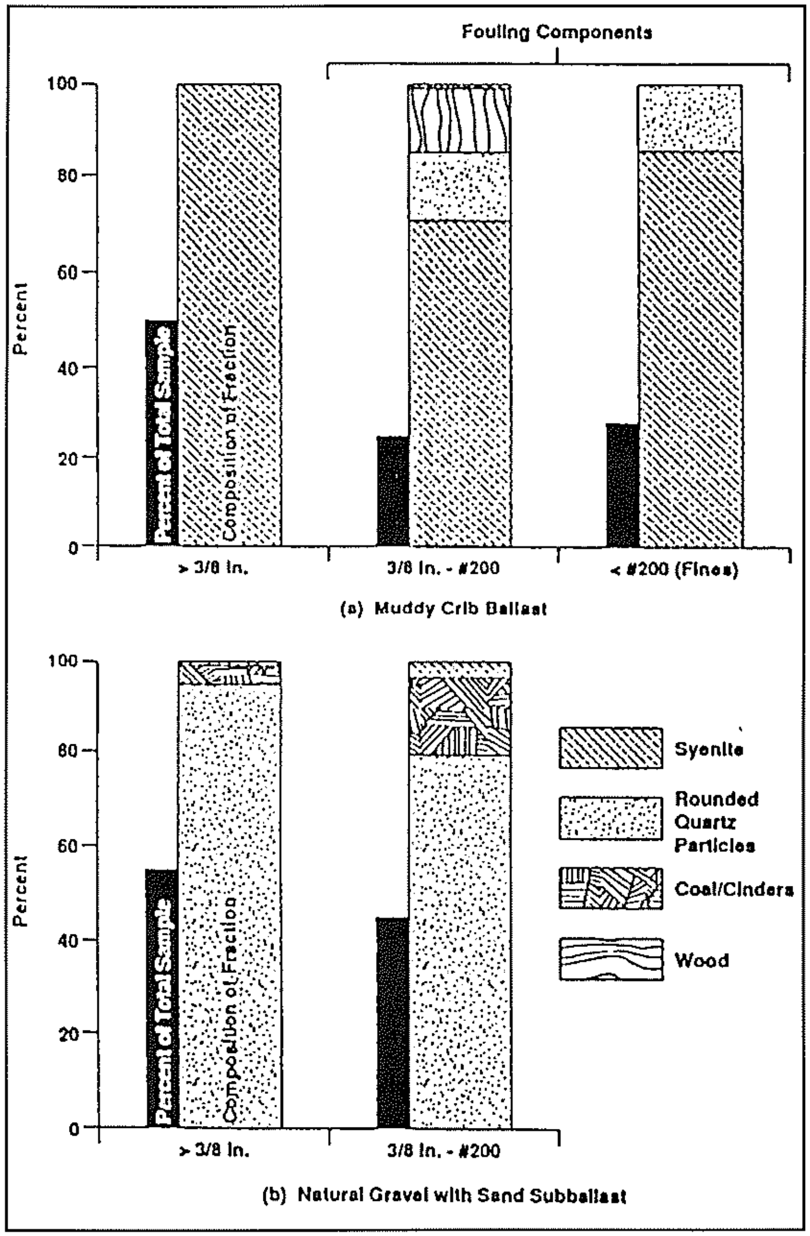

Figure 3 — Composition of ballast and subballast layers at a mud-pumping site (1).

References

(1) Selig, E. T. and DelloRusso, V., "Sources and Causes of Ballast Fouling," American Railway Engineering Association Technical Conference, March 1991.

(2) Selig, E. T., Collingwood B. I., and Field, S. W., "Causes of Ballast Fouling in Track," Bulletin of the American Railway Engineering Association, Bulletin 717, Volume 89, October 1988.