Separating Shelling or Spalling

Generally, experienced railroad maintenance personnel are familiar with different types of rail defects and problems. Yet, there often appears to be a degree of confusion among the same people with regard to the several types of rail surface defects known as shelling, spalling or flaking. In fact, these terms have been used interchangeably to describe any surface defect associated with the gage corner on the head of the rail.

But there are significant differences. While spalling and flaking refer to similar surface phenomena, shelling is a distinctively different type of rail defect, having a failure mechanism that is unlike spalling or flaking.

Spalling, or flaking, an example of which is illustrated in Figure 1, is a localized degradation of the running surface of the rail. It is most commonly found at the gage corner of the high rail. This condition often reveals itself initially as head checks (micro-cracks) at the gage corner. Usually these cracks are oriented at an angle of 45 degrees to the axis of the rail, and corresponding to the direction of traffic. The micro-cracks tend to propagate and coalesce into larger cracks or failure areas. In turn, these can break out from the surface of the head of rail. Spalling can also be found on the top surface of the rail head, often on the running surface of the low rail in curves.

Spalling, or flaking, is a surface phenomenon. It is shallow in depth, and is associated with areas of very high contact stresses. Usually, these defects do not progress deeply below the surface of the rail. Instead, they progress about 0.030 inch below the surface, towards the gage side of the railhead.[1] Spalling appears to be a surface fatigue condition related to high shear stresses as well as normal contact stressing.

Inclusion source?

On the other hand, shelling, or more specifically, Gage Corner Shelling (see Figure 2), is a progressive internal separation that develops beneath the cold-worked region at the gage corner of the rail. Such a separation may propagate longitudinally along the rail and ordinarily at an angle to the rail axis. It can crack out at any level, usually near the upper gage corner.

As the shells propagate, they can turn down and in to form a transverse separation, which is often referred to as a detail fracture from shelling. This transverse defect can develop at any stage of the shell's longitudinal propagation. And since transverse defects in general, and the detail fracture in particular, are considered to be causes of rail breakage under load with possible derailment if not detected in time, these defects are particularly dangerous.

Gage-corner shelling is a subsurface fatigue phenomenon associated with high contact stresses at the point of contact between the throat of the wheel and the

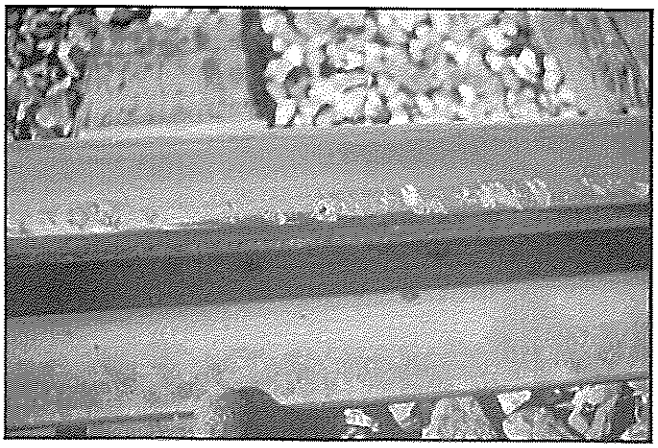

Figure 1 – Spalling is a localized degradation commonly found at the gage corner of the high rail.

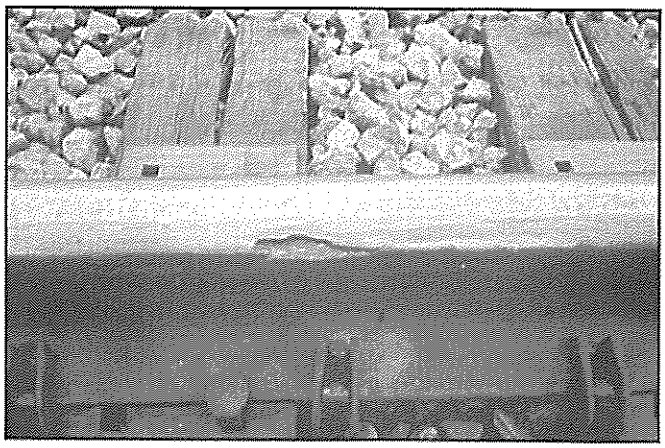

Figure 2 – Gage Corner Shelling, on the other hand, is a progressive internal separation that can 'crack out.'

gage corner of the rail. Research studies have linked shelling with the presence of inclusions within the rail steel — particularly non-metallic inclusions.[2]

It is thus apparent that the two types of rail defects, shelling and spalling, are in fact quite distinct from each other, having differing appearances, occurrence mechanisms, and failure modes.

Since these rail defects described have been found to occur in the same locations, and are related to high contact stress conditions, there is a reason for the confusion between the two. In any event, these rail surface defects appear to be on the increase (see *Tracking R&D*, January 1985). Therefore, the ability to distinguish between the two is quite important.

References:

1. Rail Defect Manual. Sperry Rail Services. Danbury, Connecticut, 1964.
2. Sonon, D. E.; Pellegrino, J. V., and Wandrisco, J. M.: "Metallurgical Examination of Rails with Service Developed Defects (Rail Analysis Volume 4)", AAR R-300, March 1978.