Abstract

This analysis investigates a possible correlation between track quality and permanent slow orders in the network of the Austrian Federal Railways. Slow orders are necessary to reduce the normal speed to a lower level either for reasons of safety or comfort. Research yields the result that a link between the alignment quality (MDZ-a quality) and the slow orders is possible. Therefore the focus was set on slow orders imposed due to poor comfort only.

Slow orders are generally temporary measures in case of critical singular failures or in case of construction sites. Urgent safety reasons like head checks or gauge problems cannot be evaluated, having no relation to track quality. In the most cases damage, abrasion, material fatigue and soiling of several components can be reasons for bad track quality and therefore create the need of a slow order. Drainage problems or bad underground conditions can also be reasons for poor track quality and thus to a speed reduction.

The source for this research is the TUG database covering the level of track quality for the main network. The Institute for Railway Engineering and Transport Economy has been studying track quality behaviour for over a decade, having set up a mathematical model to characterize the quality over time. Track quality can be described by an exponential function with the characteristic $Q_t = Q_0 \times e^{bt}$, in which "Q_t" is the actual quality at time "t", "Q_0" is the quality level after track relaying or the last maintenance action and "b" is the track deterioration rate.

The results of this analysis show the correlation between track quality and permanent slow orders. The calculation of the local track quality of a track section forms the basic data for the boxplot. The "interquartile range", abbreviated "iqr", is just the width of the box in the box-and-whisker plot in which 50% of all track quality values are in the box. It is possible to declare the need for any slow order by its track quality in comparing it to the average quality level at the whole track section. (Figure1)

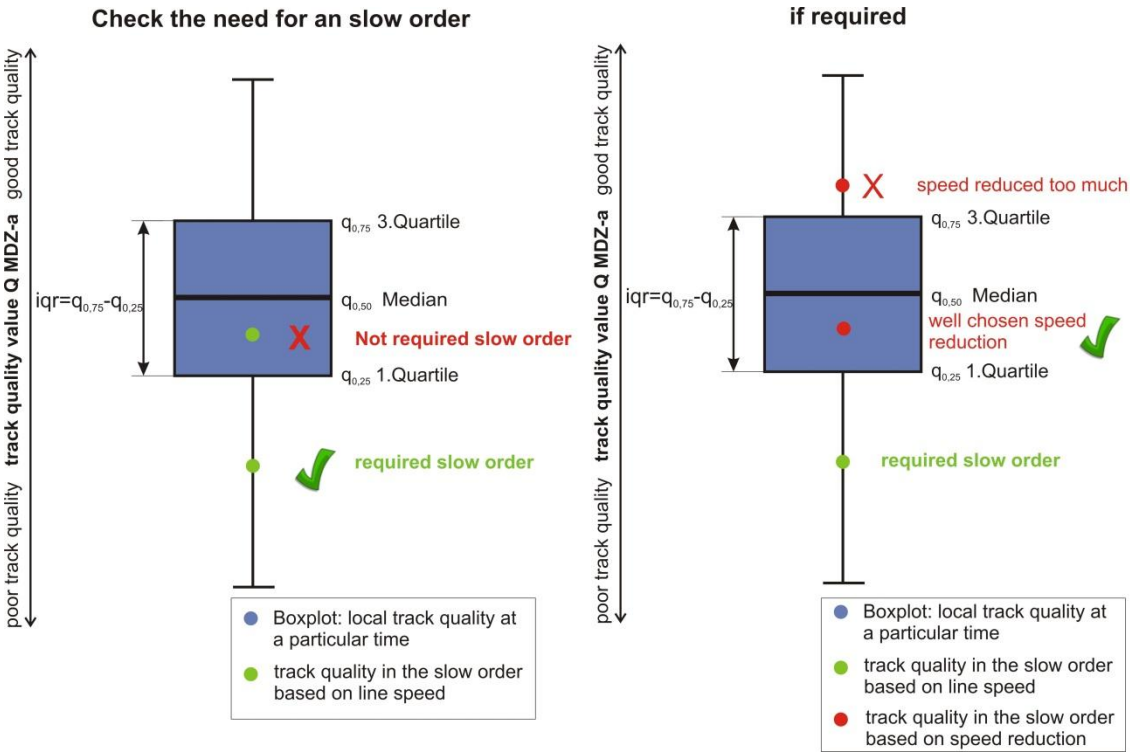
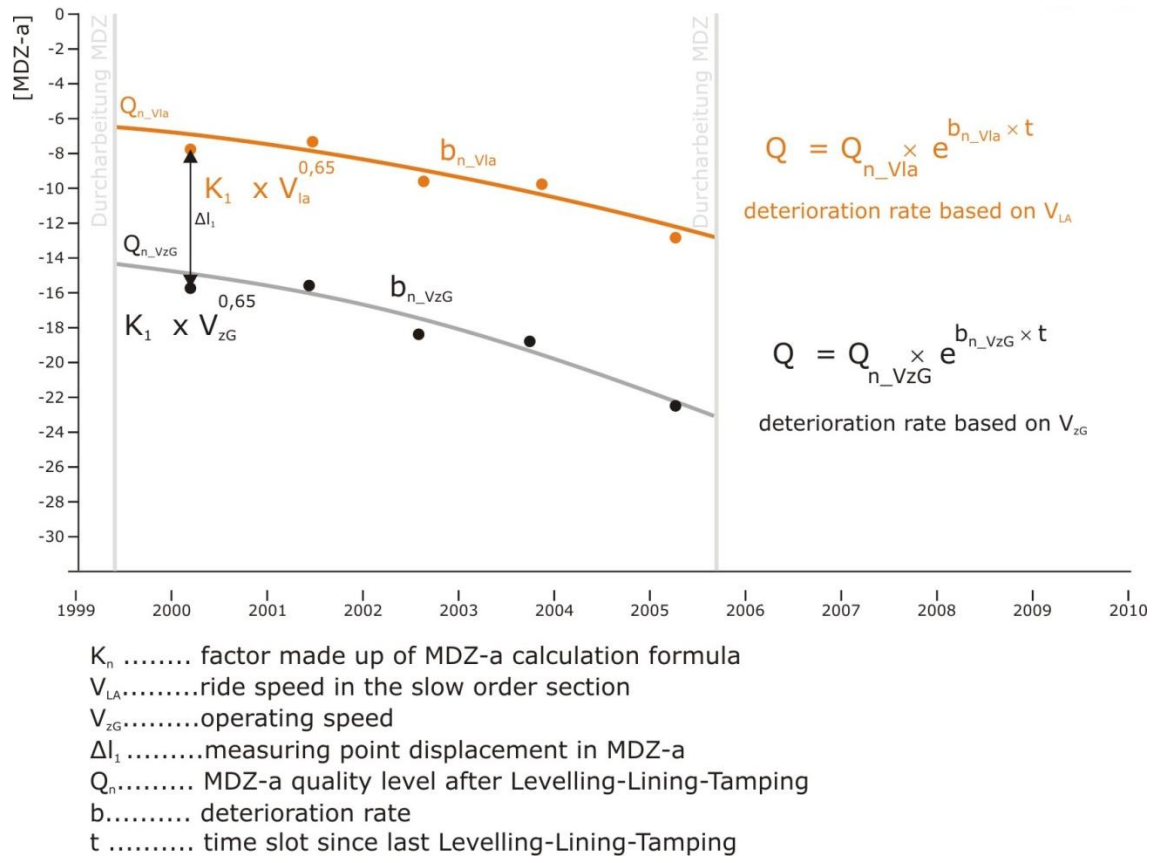


Figure 1: Analysing the necessity of a permanent slow order

Hitherto slow orders were being imposed on the basis of empirical knowledge of track engineers. With the results of this analysis it is possible to calculate the comfort quality improvement resulting from slow orders. The necessary speed limit can be calculated allowing further optimization in regard of the quality level. (Figure 2)



K_n ..... factor made up of MDZ-a calculation formula
V_{LA}.....ride speed in the slow order section
V_{zG}.....operating speed
Δl_1 .....measuring point displacement in MDZ-a
Q_n..... MDZ-a quality level after Levelling-Lining-Tamping
b..... deterioration rate
t ..... time slot since last Levelling-Lining-Tamping

Figure 2: Track quality based on speed reduction

Permanent speed restriction are actually a very costly alternative for main lines as costs of operational hindrances occurring at the train operating companies to an overwhelming part rise dramatically with upcoming delays.

The amount of operational hindrances depends on the train mix and traffic volume. Slow orders with a high length cause increasing costs. Short slow order sections like in turnouts could be also very costly because of the dynamic effect of the deceleration before the slow orders and the acceleration after it. In turnouts, slow orders could also raise the operational hindrances because elements vital for capacity are occupied for a longer period of time. If quality of permanent way does not meet the requirements anymore, a reduction of line speed level could be one measure to deal with the problem.

In this paper an approach is presented to verify the need of permanent slow orders due to quality reasons. Furthermore the required speed insuring an acceptable riding quality can be defined. However permanent speed restrictions in general cannot be justified economically in main line track due to their high costs of operational hindrances. This even more leads to the need of an evaluation, if they are really required.