CHALMERS
UNIVERSITY OF TECHNOLOGY

Cracks in turnout sleepers

Conclusions from a questionnaire to the UIC Track Expert Group

Melker Pettersson, Anders Ekberg, Rikard Bolmsvik,
Anders Hammar, Ulf Malmqvist

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Introduction

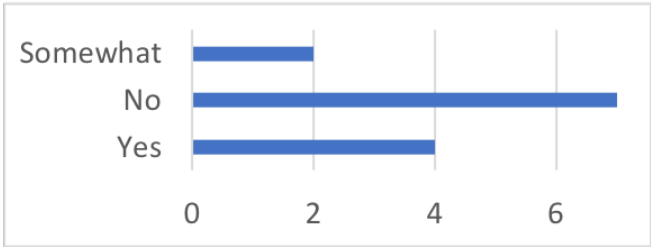
To investigate the occurrence of cracks in turnout sleepers, how these were assessed and handled, a questionnaire was sent out to 15 members of the UIC Track expert group in December 2020.

By February 20, 2021, eleven responses have been received[1]. The responses are summarised and commented below. Complete responses are included in Appendix 1.

1 Occurrence of cracks

1.1 Are longitudinal cracks in turnout sleepers a common problem?

- Somewhat 2
- No 7
- Yes 4



In most cases cracks do not seem to be a common issue. There seems to be a trend to relate cracks to older sleepers or to a certain manufacturer or sleeper design.

1.2 If YES what is the typical number of years or traffic load of the turnout sleepers before longitudinal cracks are observed?

Some IMs reported cracks occurring from manufacturing. Other reported around 10 years until cracks were visible. When reported, the growth rates were considered low.

1.3 What type of fastening system do you use in turnout sleepers?

Wide variation ranging from baseplates with screws to clip fastenings.

1.4 Where in the turnout do you have the most problem with cracked turnout sleepers, Crossing, switchblade or elsewhere?

Provides a very scattered picture. Cracks seem in many cases to occur in the entire turnout area. Specified sections mentioned are crossing section, sleepers where manoeuvring equipment mounted, in connection to joints, long bearers, areas with rail plates with sleeper screws, and in general locations with increased dynamic loads.

[1] Responding railways are ADIF, Bane NOR, DB, Infrabel, MAV, NR, ÖBB, PKP, ProRail, SNCF, Trafikverket

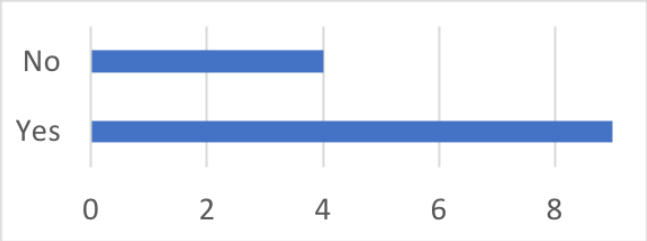
2 Crack detection

2.1 How do you detect cracks in sleepers, manually visual inspection or any other method?

In general, cracks are normally detected at visual inspections. One IM employs video inspections. In the two cases mentioned, the manual inspection rate varies between once per month to once per year.

2.2 Do you have any crack width criteria to determine the need for replacement of sleepers in track or S&C? YES OR NO:

- No 4
- Yes 9



Some infrastructure managers employ a crack width criterion with allowed crack width ranging from tenths of millimetres to some millimetres.

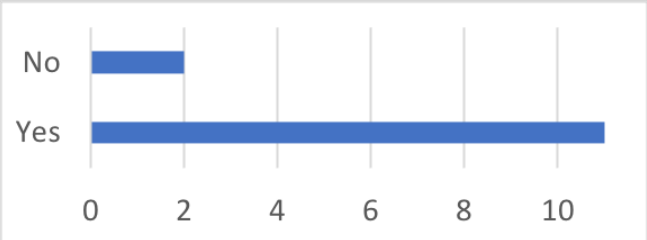
In the cases where a crack width criterion is not employed, the majority of the IMs states that other condition-based criteria is employed for sleeper replacement.

2.3 Yes on the previous question: What research or background is the basis for your criteria's?

The main motivation tends to be based on operational experience and knowledge. In addition, there are mentions of studies on corrosion and additional mechanical tests. There are also descriptions of more frequent cracking in connection to drilled holes, and due to the occurrence of Alkali-Silica reactions (ASR) and delayed ettringite formation (DEF).

2.4 Do you have some tools or manuals to help the inspector to determine if the sleeper should be exchanged or not? YES or NO:

- No 2
- Yes 11



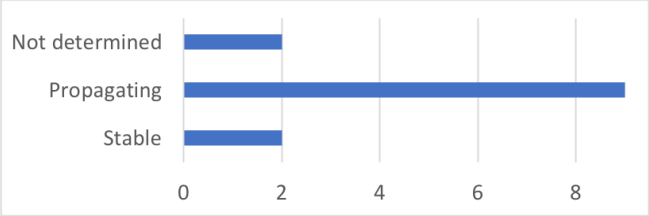
2.5 If Yes on the previous question, could you describe what help is provided or attach a manual or photos to this questionnaire?

The use of (national) standards and handbooks is very common. To link to inspections, (simple) instrumentation, such as scales to measure crack width seems to be common.

3 Sleeper crack growth rates

3.1 Do you determine if the possible cracks that you find in track are stable or do they increase in both length and width over a short period of time? STABLE or PROPAGATING

- Not determined... 2
- Propagating 9
- Stable 2



There seem to be a fairly consistent agreement that if cracks propagate, the propagation rate is slow – visible over years, not months.

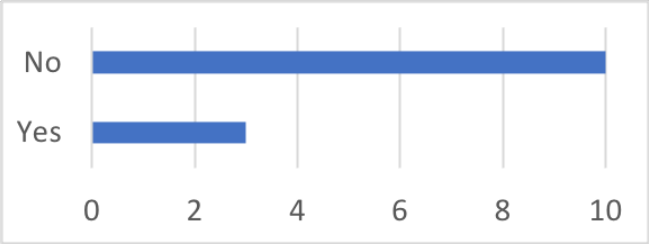
3.2 IF PROPAGATING: Describe what method do you use to determine this and keep track on the crack development

Subsequent inspections are used to follow crack growth. Inspections can be documented following national standards. Marking of the crack tip and photographs are used to be able to distinguish subsequent growth.

4 Occurrence of corrosion

4.1 Have you ever experienced corrosion of prestressed strands due to transverse or longitudinal cracks in sleepers (mainline or turnout)? YES or NO:

- No..... 10
- Yes 3



The three IMs that report that corrosion has been identified state that it is (very) rare. One IM reports corrosion on stored sleepers subjective to excessive water exposure.

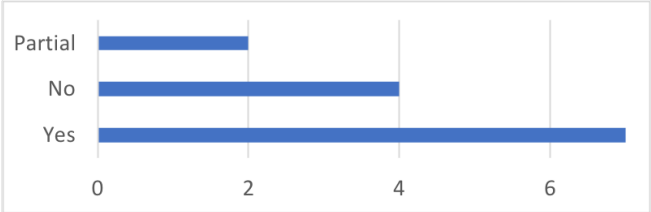
4.2 If YES on previous question, how have you determined this:

Noted during regular maintenance inspections. One IM mentions inspection focused on staining and reinforcement strand retraction. One IM mentions that aggregate-alkali reaction rather than corrosion is the root cause. One IM mentions observation after cutting a sleeper in the cracked area.

5 Cracks around fastening components

5.1 Have you determined the cause for cracks around fastening components? YES or NO

- Partial 2
- No 4
- Yes..... 7



5.2 IF Yes on previous question describe what causes have you found?

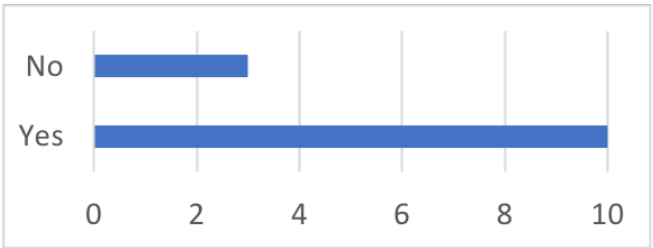
A multitude of causes are presented. Several IMs have identified excessive torque, bent sleeper screw, alkali–silicate reaction and delayed ettringite formation is also mentioned by several IMs. Other causes are stress concentrations (e.g. improperly used holes), ice formation (in dowel), and tamping damage. One IM mentions stresses due to improper positioning of sleepers.

One IM mentions notes that cracks around holes are small and can be mitigated by spirals around the dowel, cf. next question.

6 Strengthening around fastenings

6.1 Do you require any strengthening action around the fastenings (stirrups or other measures)? Yes or NO:

- No 3
- Yes..... 10



Strengthening around fastenings seems to be very common. One IM notes that this is used only in recent designs and one IM only employs reinforcement for tightly spaced holes.

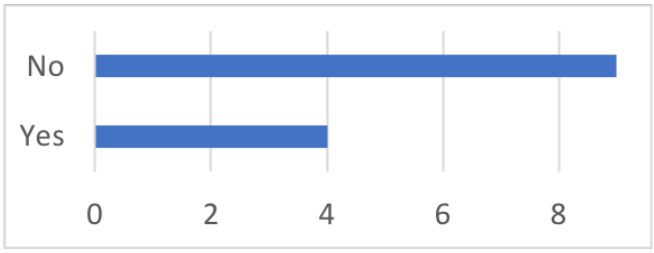
6.2 IF Yes what method do you use?

Different forms of stirrups, spirals etc seem to be common. In addition, methods to avoid cracking includes the use of greater hole spacing, water drainage, tightening control, fastener lining lubrication

7 Relation between track faults and sleeper cracking

7.1 Have you concluded any typical faults in track leading to longitudinal cracks in turnout sleepers? YES or NO:

- No..... 9
- Yes..... 4



7.2 IF YES on previous question, please describe more

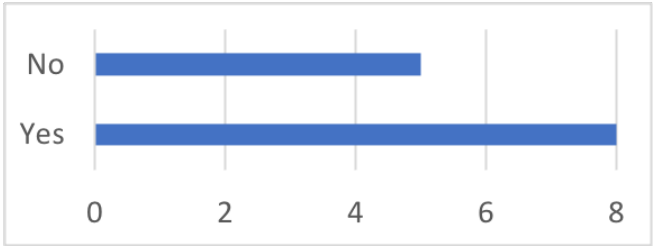
In the few cases where a relation is found to track faults, it is mentioned that (longitudinal) cracks are found where dynamic forces are increased (due to frogs).

Cracks are generally related to stress concentrations at holes and in connection to switch driving and locking devices. Cracks have also been noted to relate to long expansion joint devices.

8 Crack mitigating actions

8.1 Have you included any measures in your turnout sleeper requirements in order to prevent possible occurrence of cracks? Yes or NO

- No..... 5
- Yes..... 8



8.2 If YES on the previous question, describe what type of requirements

A number of means have been taken by the IMs to mitigate sleeper cracking. Examples include. Modified construction e.g. reinforcement around holes, abandoning drill-and-glue, improved manufacturing processes e.g. related to curing. Other means are tightened quality requirements and testing. One IM mentions tests on coating of cracked sleepers. One IM mentions use of repairs to cover cracks and thereby reduce growth during winter.

9 Concluding remarks

The report contains a brief summary of the responses from the IM. The full response is included in the appendix. From the response there seems to be consensus on some topics such that cracks commonly occur in the vicinity of holes and that they (once they are established) seem to propagate rater slowly. On other topics there seems to be much more disagreement. Most importantly, this relates to how cracks should be assessed and when (and how) they should be mitigated. Here the practice seems strongly related to operational experience, which of course complicates knowledge transfer between IMs and to upgraded operational conditions.

10 Appendices

1. UIC Track Expert Group, Measures done in order to handle possible cracks in turnout sleepers and mainline sleepers, 30 pp, 2021.