Long-term Effects of Interaction between Rolling Stock and Track/Turnout Components Regarding Maintenance Intervals and Durability

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1. Introduction

Higher speed, higher axle loads and increased traffic density require turnout and track technology with technically optimised and at the same time, economical components.

Since 35 years Schwihag develops and produces turnout rail anchoring systems and special components for the turnouts and permanent way.

The philosophy and the main objective of Schwihag is to find better technical and economical solutions for the track and turnout applications in cooperation with railway companies all over the world.

New ideas from the Schwihag research and development team are always discussed with the experts of the railway companies and scientists of well known railway research and test institutes.

From the first idea to the final approval from a railway company each Schwihag development is accompanied by intensive discussions with railway experts not only on the scientific level but also with the railway people, who work with it on a daily basis.

Further modules of the Schwihag product development process are three-dimensional design by CAD, strength analysis with FEM computer simulation and last but not least a wide range of test procedures at the Schwihag test laboratory, picture 1, and later for approval at independent research and test institutes.

This approach of product development is the reason, why Schwihag systems have proven their reliability world-wide, in more than 40 countries, in the high speed application, heavy haul, and standard operations of railways, light rail and metros.

The following performance gives a short overview about some special chosen investigations at Schwihag products, which show the long-term effects regarding maintenance intervals and durability.
2. Special results of long-term studies and tests with Schwihag systems

2.1 Effects of elastic fastening systems in points - ORE test

With the special IBSR slide chair baseplates, Schwihag has developed a universally resilient fastening system for stock rails and running rails in turnouts, picture 2.

The key element is the clip type SSB 2, for resilient fastening of the stock rail. The SSB 2 clip provides a high toe load with wide amplitude [1].

Tests, carried out in January 2, 1976 in Zaventem, Belgium, have shown, that forces and accelerations in the closure rail could be reduced for more than 50% in comparison between a rigid and an elastic fixation of the stock-rail [2].

Picture 2: IBSR raised slide plates and SSB 2 clip in UIC 60 rail [1]

2.2 Two axle repeated load test at Technical University Munich

Investigation performed at “Prüfamt für Bau von Landverkehrswegen” (Institute for road, railway and airfield constructions) of Munich Technical University at a special elastic Schwihag check rail plate system, picture 3, should show the technical performance of the key components after a Long-Term-2-Axle-Repeated-Load-Test [3].

The system, a check rail baseplate with elastic SSB 2 clip and resilient rail pad with a static stiffness of 200 kN/mm was tested according the European Standards EN 13481 and EN 13 146. The test program contents following parts:

- Longitudinal rail restraint, according to EN 13146-1
- Torsion resistance, according to EN 13146-2
- Attenuation of impact loads, according to EN 13146-3
- Effects of repeated load, according to EN 13146-4, but additional, as described in EN 13481-7, with a secondary load in horizontal direction at the centre of the check rail plate surface, where the contact to the wheel would happen.
- Vertical stiffness of the fastening system, according to EN 13146-4. paragraph 7.5.
- Determination of clamping force, according to EN 13146-7
- Stiffness of the resilient rail pad, according to EN 13481-2, attachment B

The tests shows the perfect performance of all components before and after a two-
dimensional repeated load test with 3 Million load cycles. No damages were observed and the requirements of the specification according European Standards were met!

Picture 3: IBRR check rail baseplates and SSB 2 clip [1]

2.3. Measurement of switch moving forces

Another very important product development of Schwihag, which has been examined in a wide range of laboratory and field tests is the Schwihag Integrated Roller Slide Plate IBSR.

The system, picture 4, was developed to get a lubrication free switch. This was realized with the integrated roller slide plates with sealed Molybdenum coated seat in combination (option) with slide plates with sealed Molybdenum coated slide surface or low friction slide insert (either Bronze or Molybdenum coated stainless steel)


Measurements of switch moving forces at DB-turnouts in Geislingen [4] have shown the effect of an acceptable reduction of moving forces, picture 5.
Measurement of Switch Moving Forces in Geislingen

Turnout No. 112
Station: Geislingen/West / DB
with and without Rollers System Schwihag

Diagramme Pulling

with Schwihag Rollers
Place: Geislingen date: 09.11.97 11:55:03
Name: Köhler no. of turnout: EW 60-760
Fmax: 2.8 kN Fm: 1.1 kN Pull

without Schwihag Rollers
but slide tables lubricated
Place: Geislingen date: 09.11.97 12:20:16
Name: Köhler no. of turnout: EW 60-760
Fmax: 4.6 kN Fm: 2.1 kN Pull

Measurement of Switch Moving Forces in Geislingen
Turnout No. 112
Diagramme Pushing

with Schwihag Rollers
Place: Geislingen date: 09.11.97 11:57:36
Name: Köhler no. of turnout: EW 60-760
Fmax: 2.8 kN Fm: 1.8 kN Push

without Schwihag Rollers
but slide tables lubricated
Place: Geislingen date: 09.11.97 12:20:18
Name: Köhler no. of turnout: EW 60-760
Fmax: 4.2 kN Fm: 2.7 kN Push

Picture 5: Results of measurement Geislingen/West/DB with and without Rollers System Schwihag [1]
Additional measurements in a comparison test [5] have shown, too, the effect of the reduction of moving forces and the advantages of the Schwihag roller system, picture 6.

Result of a comparison test of 7 roller devices in a switch S 54-500 of the Deutsche Bahn AG, Germany in the switch workshops of the DB in Witten/Germany

![Bar chart showing results of comparison test]

The integrated Schwihag roller slide plate has gained no. 1 in ranking in all 10 different criteria raised by the DB and therefore has reached the highest number of points and the absolutely lowest switch moving forces.

The main advantages of the Schwihag roller system are as follows:

- the integrated position of the rollers in a slide plate beside the slide chair on the sleeper
- the adjustability of the rollers lateral and vertical by means of standard tools without additional parts like shims a.s.o.
- the short time required for adjustment
- no reassembling and no special precautions are required to allow mechanical tamping of the switch assembly
- covers for new installations

**Picture 6:** Results of a comparison test of 7 roller devices in a switch S 54-500 of DB [5]
2.4. Continues embedding of turnouts in ballast by using hollow steel sleeper

The continues elasticity in track is a very important item, which is very difficult to fulfil in turnouts due to the complex design and different components like actuators and cable crossings.

Cable crossings and connecting rods of the point machine cause discontinues ballast thickness and make problems for the tamping process.

To avoid these problems, Schwihag has developed hollow sleepers for cable crossing and point machines. The Schwihag hollow sleepers are casted as one piece, which has significant benefits for the tamping, picture 7.

The casting production allows, to make a rough surface and additional sharp edges on the underside of the sleeper.

This minimises any tendency for ballast to move upwards during the tamping process or later when the train passes [6].

![Picture 7: Schwihag Hollow Steel Sleeper for actuators and cable crossings](image)

The scientific examination of the effect of reduced ballast movement in combination with hollow sleepers near critical localities in track or turnouts, like cable crossings or point machines is a very important task in the future, which Schwihag will begin
together with interested railway companies and railway institutes.

2.5. Railtrack’s Network Performance study

The Railtrack Network Performance study [7] shows very interesting results about the influence of infrastructure problems to the delays, table 1. The maximum delay was caused by point failures with 1,226,000 minutes in 1995/96.

<table>
<thead>
<tr>
<th>Detail</th>
<th>1000 minutes</th>
<th>1000 min.</th>
<th>1000 min.</th>
<th>1000 min.</th>
</tr>
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<tbody>
<tr>
<td>Infrastructure</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Points failures</td>
<td>1226</td>
<td>915</td>
<td>855</td>
<td>617</td>
</tr>
<tr>
<td>Points heater defect/failure</td>
<td>16</td>
<td>2</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Trackside sign problems</td>
<td>39</td>
<td>29</td>
<td>25</td>
<td>14</td>
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<tr>
<td>Level crossing failures</td>
<td>119</td>
<td>98</td>
<td>83</td>
<td>59</td>
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<td>TSRs due to track condition</td>
<td>765</td>
<td>531</td>
<td>535</td>
<td>413</td>
</tr>
<tr>
<td>Broken rails/track faults</td>
<td>713</td>
<td>496</td>
<td>515</td>
<td>393</td>
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<tr>
<td>Line side structure defects</td>
<td>182</td>
<td>432</td>
<td>225</td>
<td>161</td>
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<tr>
<td>Other Infrastructure</td>
<td>223</td>
<td>250</td>
<td>218</td>
<td>156</td>
</tr>
<tr>
<td>Possession overrun a. related faults</td>
<td>183</td>
<td>432</td>
<td>225</td>
<td>161</td>
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<tr>
<td>Possession work left incomplete</td>
<td>203</td>
<td>137</td>
<td>247</td>
<td>57</td>
</tr>
<tr>
<td>Mishap – infrastructure causes</td>
<td>33</td>
<td>63</td>
<td>104</td>
<td>39</td>
</tr>
<tr>
<td>Animals in line</td>
<td>126</td>
<td>137</td>
<td>98</td>
<td>102</td>
</tr>
<tr>
<td>External – weather impact</td>
<td>777</td>
<td>271</td>
<td>238</td>
<td>248</td>
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<tr>
<td>Wheel slip due to leaf fall</td>
<td>84</td>
<td>180</td>
<td>252</td>
<td>251</td>
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<tr>
<td>Fires on the infrastructure</td>
<td>81</td>
<td>45</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>4689</td>
<td>3833</td>
<td>3636</td>
<td>2663</td>
</tr>
</tbody>
</table>

Table 1: Extract of delays by cause 1995/96 – 1998/99 [7]
Remarkable is, that the points failures could be reduced about 50 % in four years by using new innovative technologies or materials [7]:

“... 4.48 The zones which have demonstrated the most consistent reduction in total delays from points failures have achieved this through the application on initiatives such as the installation of Schwihag rollers ...(… which reduce the frictional resistance to the movement of switch blades, particularly in cold weather), enhanced maintenance regimes focussed on the most critical locations, and also through improved contractor response time. …”

3. Summary

Tests, measurements and long-term experience with special Schwihag-components in track and turnout show, that there is a wide range of possibilities to reduce maintenance costs and to rise up the lifetime and long-term-performance of track and turnout components.

The developing process, of course, is not finished but it is rather in a new beginning with the implementation of new technologies and new materials. This process must be supported and pushed by the railway industry, supported by R&D-institutes, in a close cooperation with the experts of railway operators.

Further research and development activities will show the big potential for new systems, so that future systems will give more benefits, especially with view to:

- long-term technical performance under all rail traffic operation conditions
- life cycle cost reduction (e.g. higher availability and reliability by use of high quality materials and high standard quality control – ISO 9001)
- environmental protection (e.g. lubrication free components)

Schwihag is working on it since 35 years and will continue its work in the future to support railway track development for railways all over the world.

References:

[1] Schwihag product brochure, Tägerwilen, Switzerland

    Unification of the geometry of points and crossings with rails of 60 kg/m permitting high speeds on diverging track
    Report No. 3
    Tests on existing turnouts or those especially designed at the proposals of the D 121 Specialists Committee – Supplementary conclusions

    Testing of the fastening System with Check Rail Plate 60P.583U according to the European Specifications EN 13481 and EN 13146
    Technische Universität München, Lehrstuhl für Bau von Landverkehrswegen
    Univ. Prof. Dr. Ing. G. Leykauf

[5] Comparison of test roller devices in a turnout EW S54-500 of Deutsche Bahn AG in the switch workshops of the DB in Witten/Germany, 14.01.1999


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