A Switch is a track

1 Introduction

New types of maintenance contracts are based on output control. To specify the output one should define objective, transparent and reproducible parameters, tolerances and quality figures. At this moment there are no practical quality figures available for switches that can fulfil these requirements. Volker Stevin Rail &Traffic is developing additional parameters, tolerances and quality figures for switches which can fulfil the above mentioned qualifications.

These additional parameters, tolerances and quality figures are not only developed for output contracts but also for analysing the measured data in respect to the maintenance, safety and lifecycle of switches.

To come to effective and efficient maintenance we must change the concepts from time based to condition based maintenance. And I mean really condition based by measuring the condition in appropriate and accurate way.

2 Parameters for switches

Reliable parameters are very important if you want to analyse the geometry of switches. They must be objective and reproducible. Therefore it is important that they can be measured with sufficient accuracy.

2.1 Standard parameters

The standard parameters for switches in Holland are:

- Gauge
- Cant
- Twist
- Width check rail
- Check rail gauge (standard but not used often)

These parameters are designed for the static geometry of a track or a switch.

In most switches these parameters are still manually measured and only at the critical points of the switch. If you want to analyse the geometric of a switch more thoroughly it is necessary to measure not only these parameters more accurate but also throughout the whole switch.

2.2 Extra parameters

The so-called static (standard) parameters aren't telling you something about the dynamic behaviour on a running train. Static parameters can stay within their tolerances while a track or a switch still has a enormous dynamic effect on a running train.
Therefore I want to introduce some extra parameters for switches that can be measured or calculated.

- Vertical irregularities
- Horizontal irregularities
- Gauge gradient
- Switch twist (no experience yet)

The Vertical and Horizontal irregularities and the gauge gradient can tell you something about this dynamic behaviour. The new parameter Switch twist will possibly tell you

something about the quality of the turnout. Bad tamping work will cause damage or extra wear at the frog because of bending sleepers.

3 Tolerances for switches

Tolerances are very important if you want to use condition-based maintenance.

If tolerances are to width a switch will be worn out without noticing, with all the safety risks involved. Maintenance will be very costly and looks more like a renovation. The quality will be very poor.

If tolerances are to narrow the maintenance cost will also be very high, the lifecycle very short (parts will have a very short lifecycle), the availability will be very low (a lot of time for maintenance) but the reliability and safety will be very high.

3.1 Dutch tolerances

In Holland there are only a few tolerances available for switches. These tolerances are mentioned in the VTBII (Regulation Railinfrabeheer) and until now only used for the critical points:

- Gauge (nominal 1435, +5/-2 mm) and (nominal 1435, +5/0 mm) at the frog
- Cant (nominal 0, +10/-10 mm)
- Twist (nominal o, +10/-10mm)
- Width check rail (nominal 41, +2/0)
- Check rail gauge (nominal 1394, +2/-2)

4 Characteristic points in switches

Each switch has the following characteristic (critical) points and they are normally checked with manual equipment.

These characteristic points are:

- The point of the tongues
- The gap
- The heel
- The frog
- The check rail

5 Definition of quality figures:

If you want to define quality figures you should remember that they have to be:

- Objective
- Transparent
- Reproducible

Mr. Madejski from the company Graw from Poland has already explained on this conference the meaning and usage of proven quality figures used for tracks in Poland and Hungary. Using the Polish experience Volker Stevin Rail&Traffic defined additional quality figures for switches.

Quality figures can be divided into 2 groups. The first group is tolerance dependent. These quality figures change when the tolerances are changed. They are very useful to analyse the effect of maintenance or to check what line speed is appropriate.
The second group of quality figures is reference dependent. This means that they are not influenced by tolerances but compared with a reference quality figure.

5.1 Tolerance dependent Q-figures

5.1.1 Parameters Q_p

Q_p is the quality of each individual parameter. It is based on W_p used in Poland for tracks. Q_p is scaled from 1-10 and is depending on chosen tolerances.

5.1.2 Combined parameters Q_5

Q_5 is the combined quality of 5 parameters. It is based on W_5 used in Poland for tracks. Q_5 is also scaled from 1-10 and is depending on chosen tolerances.

5.1.3 Combined parameters on critical points Q_{cp}

Q_{cp} is the combined quality of the parameters on all predefined critical (characteristic) points. Q_{cp} is also scaled from 1-10 and is depending on tolerances chosen for these critical points. The tolerances are not necessarily the same as the general tolerances. They can differ for each individual critical point and parameter.

5.2 Reference dependent Q-figures

Q_j is the quality of the dynamic behaviour from the switch on a running train, compared to a reference. Q_j is scaled from 1-10 and is not depending on any tolerance at all but based on the standard deviation of dynamic parameters.

6 Measuring equipment for switches

Volker Stevin Rail & Traffic has developed in co-operation with the Polish Company Graw a measuring trolley (TEE) for switches. De TEE measures all above-mentioned parameters and calculates based on given tolerances the quality figures as mentioned. You can see a demonstration of the TEE at the exhibition.

What you see here is a standard switch type UIC54 1:9 left and a standard switch type UIC54 1:9 right. The current tolerances for the gauge is set at –2 and +5 mm according to the Dutch regulations. In the graphs the red areas are out of tolerance.

7 Measurement results

I now will show you the measurement results achieved with the TEE on 2 standard switches:

- Switch 1A 1:9 UIC54 right turnout 1-2 straight
  1-3 curve
- Switch 3A 1:9 UIC54 left turnout 1-2 straight
  1-3 curve

The current tolerances for the gauge is set at –2 and +5 mm according to the Dutch regulations. In the graphs the red areas are out of tolerance.

8 Analysis of the measured data

The switches 1A and 3A will give the following quality figures based on the earlier mentioned tolerances:

Switch	Q_5	Q_{cp}	Q_j
1A 1-2 (straight)	6,2	6,7	8,1
1A 1-3 (curve)	3,7	8,9	6,8
3A 1-2 (straight)	3,6	8,9	7,8
3A 1-3 (curve)	2,8	6,7	7,8

Switch1A 1-2 (straight)
1. Q_5 looks bad, 38% of the combined parameters is out of tolerances.
2. Q_{cp} looks bad, 33% of the critical points is out of tolerances. Intervention is necessary because safety can be in dangerous.
3. Q_j looks good, the dynamic behaviour on a running train is limited.

Switch1A 1-3 (curve)
1. Q_5 looks very bad, 63% of the combined parameters is out of tolerances. The switch should be out of service.
1. Q_{cp} looks reasonable, 11% of the critical points is out of tolerance, but attention is needed.
2. Q_j looks reasonable, the dynamic behaviour on a running train is limited.

Switch3A 1-2 (straight)
2. Q_5 looks very bad, 64% of the combined parameters is out of tolerances. The switch should be out of service.
3. Q_{cp} looks reasonable, 11% of the critical points is out of tolerances, but attention is needed.
4. Q_j looks acceptable, the dynamic behaviour on a running train is limited.

Switch3A 1-3 (curve)
1. Q_5 looks incredible bad, 72% of the combined parameters is out of tolerances. The switch should be out of service.
2. Q_{cp} looks bad, 33% of the critical points is out of tolerances. Intervention is necessary because safety can be in dangerous.
3. Q_j looks reasonable, the dynamic behaviour on a running train is limited.

8.1 Other tolerances

It seems that the Q_5 is mostly influenced by the parameter Gauge.
Therefore it is interesting to see what happens if we change the tolerances for the Gauge from [-2/+5] to values used for tracks >40km/h [-3/+7].

We don't change the tolerances for the critical points they remain [-2/+5], and [0/+5] for the frog.

Switch	Q_5	Q_{cp}	Q_j
1A 1-2 (straight)	7,8	6,7	8,1
1A 1-3 (curve)	5,0	8,9	6,8
3A 1-2 (straight)	6,0	8,9	7,8
3A 1-3 (curve)	5,4	6,7	7,8

The Q_5 looks better but still, the quality is to low.
If we change the tolerances for the Gauge to [-5/+20] (safety values) then the results looks as follows.

Switch	Q_5	Q_{cp}	Q_j
1A 1-2 (straight)	9,9	6,7	8,1
1A 1-3 (curve)	5,9	8,9	6,8
3A 1-2 (straight)	7,1	8,9	7,8
3A 1-3 (curve)	7,5	6,7	7,8

Still the Q_5 for switch 1A 1-3 (curve) stays to low.

These switches are not that bad as we think they are. We are discussing new switches here, built on concrete sleepers.

If we look at the course we will see that the gauge between the point and the heel is to narrow. This part of the switchblade is not fixed, the gauge here is determined by the correct curve made by the manufacturer of the switch.
The train seems to correct this problem while driving through the switch.

9 Decision Support Tools

Using uniform quality figures will make the analysis of switch-parameters in decision support tools for track renewal and maintenance reliable and easy. Volker Stevin Rail & Traffic will implement them in its own decision support tool called Track Information System or TRIS. Within TRIS every type of quality parameter of all linear track-objects, including points and crossings, crossovers and the alignment quality figures, can be used to generate many maintenance strategies based on time, location and financial elements. This is the real start for condition based maintenance.

A demonstration of TRIS will be also be shown in the exhibition hall.

10 Final conclusion

- Quality figures can give you the possibility to qualify a switch quickly and to compare it in time or with other switches or. If you want to start with using quality figures, it is advisable to start at the production process of the switch.

- From the geometrical point of view a switch is in fact a piece of track with some critical points. Between these characteristic points the switch acts like pieces of standard track. So on a running train the switch will have the same effect as a piece of standard track. Of course this piece of track should fulfil high tolerances, but not as high as they are defined now.

- The gauges TEC (for tracks) and TEE (for Switches) and their analysis software are very useful to develop new tolerances and to test them properly.

- The Use of experience with the new quality figures for switches is rather new, research needs to be done to check whether they are reliable enough for the feature.

11 Bibliography

1. User Manual for TEC-1435 Track Gauge, GRAW, 2000 (in Dutch)
2. VTB Railinfrabeheer
3. Railned report Inspectie infra Chloorroute, RnV/ZU/H.50.008.01 dated 27 July 2001