
# LR0619-11M GRÖNA TÅGET – REGINA 250, UIC 518 EVALUATIONS

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## Summary

On assignment from Banverket and KTH, Interfleet Technology AB has performed running dynamics tests on Regina 250, a trainset of two cars. The original Regina is a passenger vehicle used for medium distance traffic in Sweden. The tested vehicle is re-built to increase the service speed from 200 to 250 km/h. The tests were performed during the period 29 July 2006 – 8 August 2006.

The vehicle has been tested for a maximum operational speed of 250 km/h and an admissible cant deficiency of 165 mm. The usual UIC 518 procedure has been applied, with the exception that an additional curve category 900-1500 m has been introduced.

Two settings of the wheel set guidance were tested; the soft and the medium bogie setting. Due to breakdown of one of the instrumented wheelsets used for testing, data for the medium bogie setting is incomplete.

The results of the tests are:

Regina 250 with the soft bogie setting fulfils, under the tested conditions, all requirements in UIC 518 for a maximum operating speed of 250 km/h and a maximum operational cant deficiency of 165 mm. The margins towards the limit values are large, except for the comfort related car body lateral acceleration in the curve category R≥1500 m.

Regina 250 with the medium bogie setting fulfils, under the tested conditions, all requirements in UIC 518 for a maximum operating speed of 250 km/h and a maximum operational cant deficiency of 165 mm with two exceptions:

- No test results were available in the curve category 250-400 m.
- The r.m.s. value for the comfort related car body lateral acceleration $s\ddot{y}_q^*$ above leading axle 8 exceeds the limit value in the curve category R≥1500 m.

The margins towards the limit values are large, except for the car body lateral acceleration mentioned above.

A low-frequency hunting tendency was observed for both bogie settings in one curve with radius 2975 m. This lead to the exceeded limit value of the car body lateral acceleration for the medium bogie setting, and the high value for the soft bogie setting. The track forces in the curve were low for both settings.

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APPENDICES

# 1 INTRODUCTION

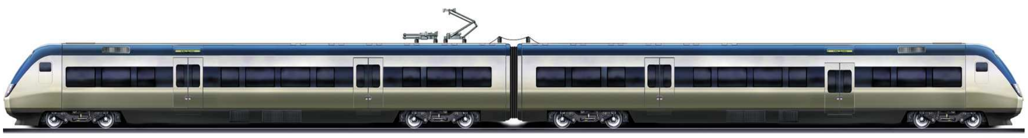
The Gröna Tåget project team consisting of KTH University, Bombardier Transportation, and Banverket seek to build and prove a *Mechatronic* bogie, utilising active radial steering and based on the existing Regina design. Interfleet has provided support for testing for the project. It is planned to undertake two phases of testing, the first phase in 2006 will test a Regina with modified bogies and primary suspension but without active steering, while phase 2, planned for 2007 will test with active radial steering.

This report covers the UIC 518 [1] evaluation of the first phase of testing without active steering.

# 2 TEST DATA

## 2.1 THE VEHICLE

The test object was X52 9062, which was rebuilt and after the rebuild called Regina 250. The trainset consists of two cars, Figure 1. The new bogie was in a vehicle dynamics point of view the most important difference compared with the original vehicle. The new bogie design aimed to increase the service speed from 200 km/h to 250 km/h. All gears were changed to allow the higher speed and the non-driven bogie was replaced with a driven bogie. The rebuilt vehicle had only driven bogies. The primary suspension was modified to ensure running stability at the higher speed, yet allowing good curving performance. Two different settings of wheelset guidance stiffness were tested. They will in this report be referred to as the soft and the medium setting. In Appendix 1 the column Trainconfig indicates the setting for each test, ±1 = soft; ±2 = medium.



**Figur 1 Layout of Regina 250**

The test vehicle was run using its own motor power, and no other vehicles were part of the test train.

The vehicle including bogies, wheels etc were tested as delivered by the customer, except for the measurement wheels which were manufactured by ITAB.

The wheel profiles were unworn S1002 with 32.5 mm flange thickness, see Appendix 5. The profiles of the instrumented wheelsets were measured without load before mounting the wheels under vehicle whereas the rest of the wheels were measured mounted under the vehicle with tare condition axle load. Those measurements were done on the lower part of the wheels close to the rail. In this position the A-measure is about 1 mm smaller than at the axle level on a loaded axle.

- Type of vehicle: Regina 250, X52 9062
- Length of the vehicle: 2 * 26.95 m
- Gross weight: 2 * 60 tonnes
- Axle load: 15 tonnes[1]
- Maximum permitted operational speed: 250 km/h
- Maximum operational cant deficiency: 165 mm

## 2.2 TEST TRACKS

Test runs were performed on the following normal gauge lines:

- Hagalund – Uppsala – Gävle – Sundsvall
- Sundsvall – Ånge (by triangulations both vehicle ends leading in both directions)
- Hagalund – Stockholm C – Järna – Nyköping
- Järna – Katrineholm – Hallsberg – Töreboda – Skövde

In the plots abbreviations for station names are used according to Table 1.

| Station | Abbreviation |
|---|---|
| Flen | Fle |
| Gävle | Gä |
| Hallsberg | Hpbg |
| Järna | Jn |
| Katrineholm | K |
| Nyköping | Nk |
| Regomatorp | Rmtp |
| Skutskär | Sur |
| Skövde | Sk |
| Stockholm C | Cst |
| Solna | So |
| Stöde | Std |
| Sundsvall | Suc |
| Södertälje Syd | Söö |
| Töreboda | T |
| Uppsala | U |
| Ulriksdal | Udl |
| Vattjom | Vm |
| Ånge | Åg |
| Älvsjö | Äs |
| Örbyhus | Öh |

**Table 1. Station name abbreviations.**

[1] See appendix 4 for bill of weight

## 2.3 TEST RECORD

In Appendix 1 there is information for tracks, test numbers et cetera. UNE in the table shows whether the test is run on single track (E), up track (U/U1) or down track (N/N1). Trainconfig is a code for soft (1) or medium (2) setting, the sign of trainconfig shows the direction of axle 1 related to the direction of kilometres (kmp) on the line. A positive sign means that axle 1 points towards increasing kmp, a minus that axle 8 points towards increasing kmp irrespective of the direction of travel.

## 2.4 WEATHER CONDITIONS DURING TESTS

The weather was generally dry and sunny, with temperatures over +20°C. The wheel-rail friction was with one exception high. During test 226 on the up track Rmtp – T, in test zone "straight track" with leading axle 8 Soft setting the friction was moderate due to haze. No sections with wet track conditions are included in the evaluation. The drivers of the train did continuously estimate and report the friction conditions.

## 2.5 RAIL LUBRICATION

On-track rail lubrication equipment was in use during the tests. This specially applies to the test zone with 250 – 400 m curve radii. Also some sections in the 400 – 600 m curve radii test zone are affected by lubrication. Lubricating the outer rail in curves is known from simulations to have an adverse effect on the radial steering capability and therefore the Y-forces and also the Y/Q ration can be higher than it would have been without lubrication.

# 3 METHOD

## 3.1 MEASUREMENT SIGNALS

The instrumentation for the UIC 518 test was unchanged during the entire series of tests. See Appendix 2 for transducer positions. (As other tests were made simultaneously with the UIC 518 test, also other equipment is shown in the appendix.)

- Two instrumented wheelsets, mounted at the bogie closest to the A end of the trainset.
- One accelerometer mounted on each of the four bogie frames, measuring lateral accelerations. The accelerometers were positioned close to axles 1, 4, 5 and 8.
- Two accelerometers in the car body over each of the four bogies, measuring lateral and vertical accelerations.
- Three accelerometers in the DMA car body in the middle between the bogies.
- One axle box mounted accelerometer on the left hand side of axle 2 measuring uncompensated lateral acceleration in the track plane.

All measurement signals were digitised and stored in the Interfleet Technology AB measurement system based on MGCplus from Hottinger Baldwin Messtechnik GmbH see Appendix 3.

Depending on the frequency range the signals were sampled with 1200 or 300 Hz. The anti aliasing filters were set to a cut-off frequency defined by the 3 dB attenuation point to 300 or 50 Hz [2]. These filters were 4 poles Butterworth type. Before the evaluations in this report the data is filtered further, all in accordance with the leaflet UIC 518.

## 3.2 EVALUATION

### 3.2.1 UIC 518 and deviations

The evaluation has been performed according to a slightly modified version of UIC 518, with limit speed $V_{lim}$=250 km/h and cant deficiency $I_{adm}$=165 mm. In the statistical processing per test zone the one-dimensional method was used for straight track and the two-dimensional statistical method for the curves in order to estimate the maximum value of an assessment quantity. The only deviation from the evaluation method according to leaflet UIC 518 consists in one extra curve category, of radius 900 – 1500 m.

### 3.2.2 Stability

In order to verify the stability the track shift forces have been evaluated according to the UIC 518 instability criterion, sliding r.m.s. value for $\sum Y$ calculated over

[2] In Appendix 3 a cut-of frequency of 40 Hz at1 dB attenuation is shown, this is equal to 50 Hz at 3 dB attenuation

100 m. The eigen frequencies were obtained by Fourier analysing the signals over those sections were sinuous behaviour were observed. From this analysis it was found that two different settings of the band pass filters should be used, f0=5.5 Hz at straight track and 2 Hz in curves.

### 3.2.3 Track quality

In UIC518, it is suggested, but not mandatory, that the test sections have a certain distribution of quality, and that the distribution is graphically revised. In this report, the proportions of track used in different quality classes defined in UIC518 are presented in Table 3. The proportions are not for all curve classes as suggested in the standard.

### 3.2.4 Radius Classes

Apart from the radius classes prescribed in UIC518, the class of radii between 900 m and 1500 m has been evaluated. The routines usually applied to the class of curves of radii between 400 m and 600 m was applied.

### 3.2.5 Number of Sections per Radius Class

The number of sections used for evaluation is as presented in table 2. All required sections are found for the soft bogie setting.

For the medium setting the test zone with small radius curves has been omitted due to breakdown of one of the instrumented wheelsets. Regarding the large radii test zone only the tests with axle 1 leading are presented. In the opposite direction sufficient speed and cant deficiency was only obtained in three sections.

In UIC 518, it is required that at least 20% of all sections in respective test zone shall have a cant deficiency of (1.05 - 1.15)*$I_{adm}$. This is not fulfilled in all test zones but this is in this case not considered to be critical. No safety related assessment criterion is close to the limit value.

| Bogie setting | Leading axle | | Straight track | 250≤R<400 m | 400≤R<600 m | 900≤R<1500 m | 1500 m ≤R |
|---|---|---|---|---|---|---|---|
| Soft | 1 | Total | 53(25) | 31(25) | 55(50) | 26 | 34(25) |
| | | 1.05*$I_{adm}$ | - | 13(6) | 7(11) | 3 | 8(7) |
| | 8 | Total | 50(25) | 31(25) | 105(50) | 26 | 28(25) |
| | | 1.05*$I_{adm}$ | - | 15(6) | 20(21) | 2 | 5(6) |
| Medium | 1 | Total | 49(25) | No Data | 53(50) | 38 | 17(25) |
| | | 1.05*$I_{adm}$ | - | - | 12(11) | 2 | 4(5) |
| | 8 | Total | 45(25) | No Data | 55(50) | 11 | 3(25) |
| | | 1.05*$I_{adm}$ | - | - | 14(11) | 0 | 0(5) |

Table 2. Number of sections in evaluation. Number of sections prescribed in UIC518 in parenthesis.

### 3.3 TRACK QUALITY

In Table 3 the track quality for the test zones is presented. The figures are the relative share of each track quality levels in percent of all sections in a certain zone. Also the recommended distribution is shown.

Quality levels:
QN1 – Equal or better than QN1
QN2 – Between QN1 and QN2
QN3 – Between QN2 and QN3

| Alignment | Quality level | Recommended distribution | Straight track | 250≤R<400 m | 400≤R<600 m | 900≤R<1500 m | 1500 m ≤R |
|---|---|---|---|---|---|---|---|
| NL std Vertical | QN1 | 50 | 48 | 81 | 99 | 74 | 100 |
| | QN2 | 40 | 31 | 8 | 1 | 16 | 0 |
| | QN3 | 10 | 21 | 11 | 0 | 10 | 0 |
| D std Lateral | QN1 | 50 | 68 | 50 | 98 | 57 | 93 |
| | QN2 | 40 | 30 | 29 | 2 | 38 | 7 |
| | QN3 | 10 | 2 | 21 | 0 | 5 | 0 |
| NL peak Vertical | QN1 | | 23 | 95 | 99 | 66 | 90 |
| | QN2 | | 70 | 5 | 1 | 31 | 10 |
| | QN3 | | 6 | 0 | 0 | 3 | 0 |
| D peak Lateral | QN1 | | 94 | 100 | 100 | 100 | 98 |
| | QN2 | | 4 | 0 | 0 | 0 | 2 |
| | QN3 | | 2 | 0 | 0 | 0 | 0 |

Table 3 Track quality distribution for the test zones

## 3.4 LIMIT VALUES

The limit values based on 15.7 [3]tonnes axle load are as follows:

(UIC no refers to the number in the table on page 56-57 of UIC 518, Name in plot indicates where to find a plot showing the value in the appendices. All plot appendices have similar structure.)

| Description<br>Name in plot | Denotation | Limit value | UIC no |
|---|---|---|---|
| Track shift force<br>S1 2m 99.85%, S1 2m 0.15% – axle 1<br>S2 2m 99.85%, S2 2m 0.15% – axle 2 | $\Sigma Y_{2m}$ | 61.4 kN | 1 |
| Flange climbing quotient<br>Y/Q11, Y12 2m 99.85 – axle 1<br>Y/Q21, Y22 2m 99.85 – axle 2 | $(Y/Q)_{2m}$ | 0.8 | 2 |
| Sliding r.m.s. of track shift force | $\Sigma Y_{100m}$ | 30.7 kN | 10 |

Table 4 Limit values for safety related assessment quantities

| Description<br>Name in plot | Denotation | Limit value | UIC no |
|---|---|---|---|
| Vertical dynamic wheel rail force<br>Q11, Q12, Q21, Q22 20Hz LP 99.85% | $Q$ | 163.55 kN | 5 |
| Lateral quasistatic wheel rail force<br>Y11, Y12 20Hz LP Average – axle 1<br>Y21, Y22 20Hz LP Average – axle 2 | $Y_{qst}$ | 60 kN | 6 |
| Vertical quasistatic wheel rail force<br>Q11, Q12, Q21, Q22 20Hz LP Average | $Q_{qst}$ | 145 kN | 7 |

Table 5 Limit values for track fatigue related assessment quantities

| Description<br>Name in plot | Denotation | Limit value | UIC no |
|---|---|---|---|
| Max value car body lateral acceleration<br>y..*1I 0.4-10Hz BP 99.85% 0.15% – over bogie 1<br>y..*1II 0.4-10Hz BP 99.85% 0.15% – over bogie 2 | $\ddot{y}^*_q$ | 2.5 m/s$^2$ | 8 |
| Max value car body vertical acceleration<br>z..*1I 0.4-10Hz BP 99.85% 0.15% – over bogie 1<br>z..*1II 0.4-10Hz BP 99.85% 0.15% – over bogie 2 | $\ddot{z}^*_q$ | 2.5 m/s$^2$ | 8 |
| r.m.s. value car body lateral acceleration<br>y..*1I 0.4-10Hz BP Std – over bogie 1<br>y..*1II 0.4-10Hz BP Std – over bogie 2 | $s\ddot{y}^*_q$ | 0.5 m/s$^2$ | 8 |
| r.m.s. value car body vertical acceleration<br>z..*1I 0.4-10Hz BP Std – over bogie 1<br>z..*1II 0.4-10Hz BP Std – over bogie 2 | $s\ddot{z}^*_q$ | 0.75 m/s$^2$ | 8 |
| Quasistatic lateral car body acceleration<br>y..*1I Average – over bogie 1<br>y..*1II Average – over bogie 2 | $\ddot{y}^*_{qst}$ | 1.5 m/s$^2$ | 9 |

Table 6 Limit values for running behaviour related assessment quantities

[3] Axle loads in Appendix 4 Weighing Protocol are lower – 15.1 and 15.2 respectivly. The limits values are based on an axleload adjusted for the weight of the personell on the test train.

### 3.5 PRESENTATION

Appendices 6 to 21 contain the results from the evaluation according to UIC 518. The following structure has been used:

Appendices are grouped five and five.

| | |
|---|---|
| 1st | Straight track |
| 2nd | Full curves: 250m ≤ radii < 400m. |
| 3rd | Full curves: 400m ≤ radii ≤ 600m. |
| 4th | Full curves: 900m ≤ radii ≤ 1500m. |
| 5th | Full curves: 1500m ≤ radii |

## 4 RESULTS

In the tables below the estimated maximum value of the assessment quantities for each test zone are computed from the 0.15, 50 or 99.85 centiles of the histograms or from the r.m.s. from each tested section. The one dimensional method has been used for straight track while the two dimensional method has been used in small and large radius curves.

### 4.1 EXCEEDED LIMIT VALUE FOR $s\ddot{Y}_Q^*$

The assessment quantity for the r.m.s. value of the car body lateral acceleration $s\ddot{y}_q^*$ is exceeding the limit value for the medium setting in the 1500 m ≤ R test zone see Table 9. This is caused by the sinuous behaviour explanied in 4.3 below.

### 4.2 BAR PLOT PRESENTATIONS

For detailed results all UIC 518 bar plots are found in Appendix 6 to 22.

In appendices 6 to 22 the abbreviation (ext. in curve sel.) can be seen. This indicates that the, according to UIC518 Appendix F, appropriate percentile (99.85% or 0.15%) depending on the curve direction has been selected for the plot.

### 4.3 SAFETY ASSESSMENT CRITERIA

The results for safety related assessment criteria are as follows:

| Quantity tested | Test zone | Max Estimated Value | | Percentage of Limit | |
|---|---|---|---|---|---|
| | | Soft bogie setting | Medium bogie setting | Soft bogie setting | Medium bogie setting |
| *Y/Q* | 250 m ≤ R < 400 m | 0.73 | No data | 91 | No data |
| | 400 m ≤ R < 600 m | 0.53 | 0.51 | 66 | 64 |
| | 900 m ≤ R < 1500 m | 0.46 | 0.40 | 58 | 50 |
| | 1500 m ≤ R | 0.35 | 0.38 | 44 | 48 |
| *ΣY* | Straight track | 27 | 31 | 44 | 50 |
| | 250 m ≤ R < 400 m | 43 | No data | 70 | No data |
| | 400 m ≤ R < 600 m | 35 | 37 | 57 | 60 |
| | 900 m ≤ R < 1500 m | 35 | 40 | 57 | 65 |
| | 1500 m ≤ R | 38 | 40 | 62 | 65 |

Table 7 Estimated maximum safety related assessment criteria, as absolute values and as percentage of the limit values

As seen in the columns Percentage of Limit all safety related quantities are well within the limits. With the exception of Y/Q in small radius curves on straight track they are very well within the limits.

The highest results from the stability evaluation are shown in Table 8:

| Test | Stations | Track | Kmp | Speed [km/h] | *Eigen frequency* | *Bogie setting* | $\sum Y_{100m}$ [kN] |
|---|---|---|---|---|---|---|---|
| 330 | Rmtp-T | U | 303+500 | 267 | 5.5 | Medium | 15.1 |
| 354 | Rmtp-T | U | 303+500 | 273 | 5.5 | Medium | 12.0 |
| 391 | Öh-Sur | N | 86+800 | 252 | 2 | Soft | 8.0 |
| 419 | Öh-Sur | N | 86+800 | 253 | 2 | Medium | 6.3 |

**Table 8 Instability criterion ∑Y r.m.s over 100 m sliding window (UIC 518 Normal method)**

As can be seen in Table 8 the results for $\sum Y_{100m}$ are very far from the limit value 30.7 kN.
∑Y-[4], lateral accelerometer- and speed signals for these occasions are shown vs. kilometres in Appendix 23. The occasions with two highest $\sum Y_{100m}$ with 5.5 Hz eigen frequency are presented in the appendix page 1 and 2 where tests 330 and 354 on the up track between Sk and T, kmp 302+500 m – 304+500 m are shown. On this location there is a transition curve between a left and a right hand curve with 8333 m radius. In the diagrams it can be seen that the oscillations are rapidly attenuated and there is no instability.
The two highest $\sum Y_{100m}$ with 2 Hz eigen frequency are obtained on the down track between Öh and Sur in a circular curve with 2975 m radius. In Appendix 23 page 3 and 4 tests 391 and 419 kmp 85+250 m – 88+100 m are shown. These diagrams also shows the uncompensated lateral acceleration (ya) and the yaw rate (Gyro). It can be seen that ∑Y is sinuous, however at a low level, throughout the entire curve. The same curve was passed with both the soft and the medium bogie setting with quite similar results in $\sum Y_{100m}$.

[4] Shown as (Y11-Y12) and (Y21-Y22) in appendix 23

## 4.4 TRACK FATIGUE RELATED ASSESSMENT QUANTITIES

The results for track fatigue related assessment criteria are as follows:

| Quantity tested | Test zone | Max Estimated Value | | Percentage of Limit | |
|---|---|---|---|---|---|
| | | Soft bogie setting | Medium bogie setting | Soft bogie setting | Medium bogie setting |
| $Q$ | Straight track | 103 | 104 | 63 | 64 |
| | 250m ≤ R < 400m | 114 | No data | 70 | No data |
| | 400 m ≤ R < 600 m | 116 | 119 | 71 | 73 |
| | 900 m ≤ R < 1500 m | 120 | 118 | 73 | 72 |
| | 1500 m ≤ R | 113 | 110 | 69 | 67 |
| $Y_{qst}$ | 250 m ≤ R < 400 m | 44 | No data | 73 | No data |
| | 400 m ≤ R < 600 m | 21 | 24 | 35 | 40 |
| $Q_{qst}$ | 250 m ≤ R < 400 m | 99 | No data | 68 | No data |
| | 400 m ≤ R < 600 m | 98 | 102 | 68 | 70 |

Table 9 Estimated maximum track fatigue related assessment criteria, as absolute values and as percentage of the limit values

As seen in the columns Percentage of Limit all track fatigue related quantities are very well within the limits.

## 4.5 RUNNING BEHAVIOUR RELATED ASSESSMENT QUANTITIES

The results for running behaviour related assessment criteria are as follows:

| Quantity tested | Test zone | Max Estimated Value | | Percentage of Limit | |
|---|---|---|---|---|---|
| | | Soft bogie setting | Medium bogie setting | Soft bogie setting | Medium bogie setting |
| $\ddot{y}_q^*$ | Straight track | 1.0 | 0.86 | 40 | 34 |
| | 250 m ≤ R < 400 m | 0.77 | No values | 31 | No values |
| | 400 m ≤ R < 600 m | 0.77 | 0.76 | 31 | 30 |
| | 900 m ≤ R < 1500 m | 0.74 | 0.74 | 30 | 30 |
| | 1500 m ≤ R | 1.1 | 1.2 | 44 | 48 |
| $\ddot{z}_q^*$ | Straight track | 2.2 | 2.2 | 88 | 88 |
| | 250 m ≤ R < 400 m | 0.80 | No values | 32 | No values |
| | 400 m ≤ R < 600 m | 0.87 | 0.94 | 35 | 38 |
| | 900 m ≤ R < 1500 m | 1.0 | 0.94 | 40 | 38 |
| | 1500 m ≤ R | 0.61 | 0.68 | 24 | 27 |
| $s\ddot{y}_q^*$ | Straight track | 0.34 | 0.35 | 68 | 70 |
| | 250 m ≤ R < 400 m | 0.28 | No values | 56 | No values |
| | 400 m ≤ R < 600 m | 0.29 | 0.27 | 58 | 54 |
| | 900 m ≤ R < 1500 m | 0.24 | 0.29 | 48 | 58 |
| | 1500 m ≤ R | 0.47 | 0.54 | 94 | 108 |
| $s\ddot{z}_q^*$ | Straight track | 0.62 | 0.63 | 83 | 84 |
| | 250 m ≤ R < 400 m | 0.29 | No values | 39 | No values |
| | 400 m ≤ R < 600 m | 0.32 | 0.36 | 43 | 48 |
| | 900 m ≤ R < 1500 m | 0.35 | 0.31 | 47 | 41 |
| | 1500 m ≤ R | 0.21 | 0.22 | 28 | 29 |
| $\ddot{y}_{qst}^*$ | 250 m ≤ R < 400 m | 1.4 | No values | 93 | No values |
| | 400 m ≤ R < 600 m | 1.4 | 1.4 | 93 | 93 |
| | 900 m ≤ R < 1500 m | 1.4 | 1.4 | 93 | 93 |
| | 1500 m ≤ R | 1.4 | 1.2 | 93 | 80 |

Table 10 Estimated maximum running behaviour related assessment criteria as percentage of the limit values

As seen in the columns Percentage of Limit, with the exception of $s\ddot{y}_q^*$ the running behaviour related quantities are within the limits. The estimated max value for $s\ddot{y}_q^*$ in large radius curves with medium bogie setting is 108 % of the limit value.

This exceedance is caused by the running behaviour in the two large radius sections around kmp 86+500 m as shown in Appendix 23 page 3 and 4. The sections can be found in the bar charts in Appendix 19.6 where the two rightmost bars represent the two sections around kmp 86+500 m.

# 5 CONCLUSIONS

Regina 250 with the soft bogie setting fulfils, under the tested conditions, all requirements in UIC 518 for a maximum operating speed of 250 km/h and a maximum operational cant deficiency of 165 mm. The margins towards the limit values are large, except for the comfort related car body lateral acceleration in the curve category R≥1500 m.

Regina 250 with the medium bogie setting fulfils, under the tested conditions, all requirements in UIC 518 for a maximum operating speed of 250 km/h and a maximum operational cant deficiency of 165 mm with two exceptions:

- No test results were available in the curve category 250-400 m.
- The r.m.s. value for the comfort related car body lateral acceleration $s\ddot{y}_q^*$ above leading axle 8 exceeds the limit value in the curve category R≥1500 m.

The margins towards the limit values are large, except for the car body lateral acceleration mentioned above.

A low-frequency hunting tendency was observed for both bogie settings in one curve with radius 2975 m. This lead to the exceeded limit value of the car body lateral acceleration for the medium bogie setting, and the high value for the soft bogie setting. The track forces in the curve were low for both settings.

# 6 REFERENCES

[1] UIC 518, 2nd edition, April 2003.