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Increased Road Surface Unevenness after the Installation of an Electric Road System

Introduction

Incorporating Electric Road Systems (ERS) into a road infrastructure will affect traditional construction, maintenance, and operational procedures. The aim of this study was to investigate effects on road unevenness measurement methods after the reinstatement of drainage and power supply tracks.

Power Supply and Drainage

Electric supply cables and drainage ducts will need to be installed across the carriageway. Tracks will be excavated at regular intervals along the length of the ERS installation. The distance between tracks will vary depending on the type of ERS system and longitudinal low points.

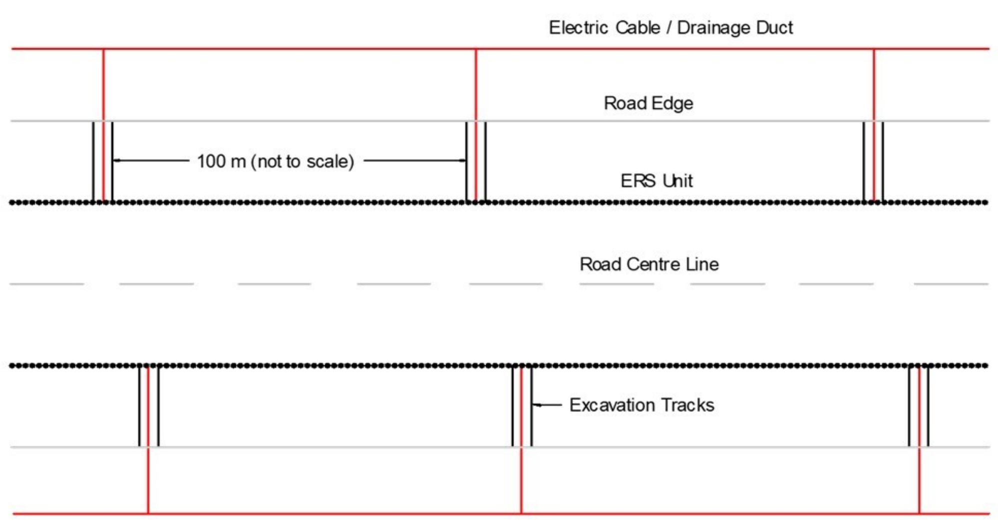

Figure 1. Power supply and drainage duct plan.

Reinstatement Tolerances

Pavement structure reinstatements should be laid flat and flush with the adjacent surfaces - no significant depression or crowning should be apparent. However, it is difficult to compact a reinstatement to the same levels as the surrounding pavement structure - post compaction will occur from traffic loading.

An amount of surface level variation will be acceptable to Road Authorities provided it is within specified tolerance levels. This means that certain levels of edge depression, surface depression, and surface crowning could be apparent after a track has been reinstated. This will be experienced by motorists as a type of local unevenness.

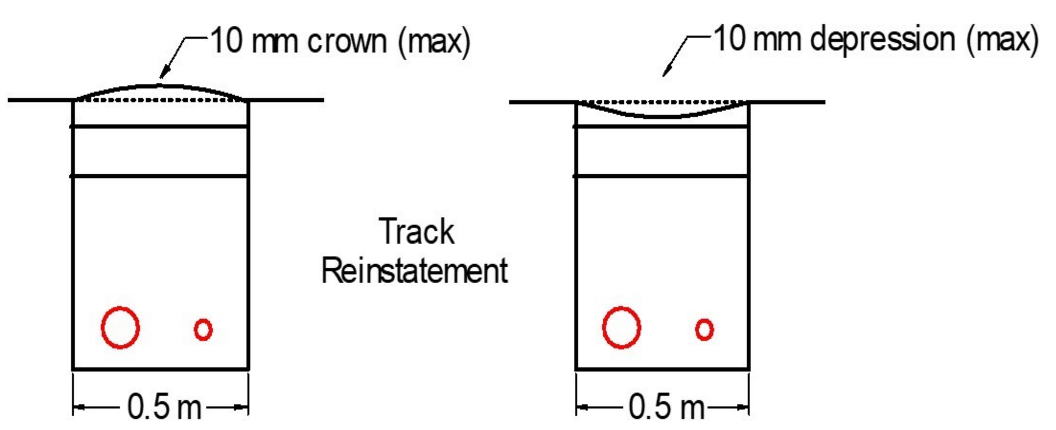

Figure 2. Track reinstatements.

To try and quantify the extent of this unevenness, international roughness index (IRI) values were calcultaed along simulated longitudinal profiles with repetative surface irregularities.

Simulation Results

The distance between the irregularities was 100 m. As tolerance levels for track reinstatements are not likely to be greater than 10 mm, the height or depth of the irregularities varied between -10 mm and 10 mm in each simulation. The width of the irregularity was 500 mm. The form of the irregularities was either surface depression or surface crowning. Consideration was not given to edge depression . Simulations were carried out for six sections with initial IRI levels ranging between 0.00 and 12.26.

The results, summarised in Table 1, show very low increases in IRI values for each profile simulation. As expected, the increases had a greater effect on the profiles with the low initial IRI values.

Table 1. Increase in IRI levels (100 m average values, mm/m and %) as a factor of defect severity and original IRI level.

	Orig. IRI										
Defect height [mm]	0	0.6		1.2263		2.4526		6.1316		12.2632	
-10	0.23	0.20	33.7	0.17	14.1	0.15	6.0	0.10	1.6	0.07	0.5
-9	0.21	0.18	30.1	0.15	12.5	0.13	5.2	0.09	1.4	0.06	0.5
-8	0.18	0.16	26.4	0.13	10.8	0.11	4.4	0.07	1.2	0.05	0.4
-7	0.16	0.14	22.8	0.11	9.2	0.09	3.7	0.06	0.9	0.04	0.3
-6	0.14	0.12	19.3	0.09	7.6	0.07	3.0	0.05	0.7	0.03	0.2
-5	0.12	0.09	15.7	0.07	6.0	0.06	2.3	0.03	0.5	0.02	0.2
-4	0.09	0.07	12.2	0.05	4.4	0.04	1.6	0.02	0.4	0.01	0.1
-3	0.07	0.05	8.8	0.04	3.0	0.03	1.0	0.01	0.2	0.01	0.1
-2	0.05	0.03	5.5	0.02	1.6	0.01	0.5	0.01	0.1	0.00	0.0
-1	0.02	0.01	2.5	0.01	0.5	0.00	0.2	0.00	0.0	0.00	0.0
0	0.00	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0
1	0.02	0.01	2.3	0.00	0.4	0.00	0.1	0.00	0.0	0.00	0.0
2	0.05	0.03	5.2	0.02	1.3	0.01	0.4	0.00	0.0	0.00	0.0
3	0.07	0.05	8.4	0.03	2.6	0.02	0.8	0.01	0.1	0.00	0.0
4	0.09	0.07	11.8	0.05	4.0	0.03	1.3	0.01	0.2	0.00	0.0
5	0.12	0.09	15.2	0.07	5.5	0.05	1.9	0.02	0.4	0.01	0.1
6	0.14	0.11	18.8	0.09	7.1	0.06	2.6	0.03	0.5	0.01	0.1
7	0.16	0.13	22.3	0.11	8.7	0.08	3.3	0.04	0.7	0.02	0.2
8	0.18	0.16	25.9	0.13	10.3	0.10	4.0	0.05	0.9	0.03	0.2
9	0.21	0.18	29.5	0.15	11.9	0.12	4.7	0.07	1.1	0.03	0.3
10	0.23	0.20	33.1	0.17	13.6	0.14	5.5	0.08	1.3	0.04	0.4

In Figure 3 below, an extract from Trafikverkets PMSv3 database, road surface characteristics are presented for a typical section of motorway. This section is a good example of the type of road that would form part of a future ERS network.

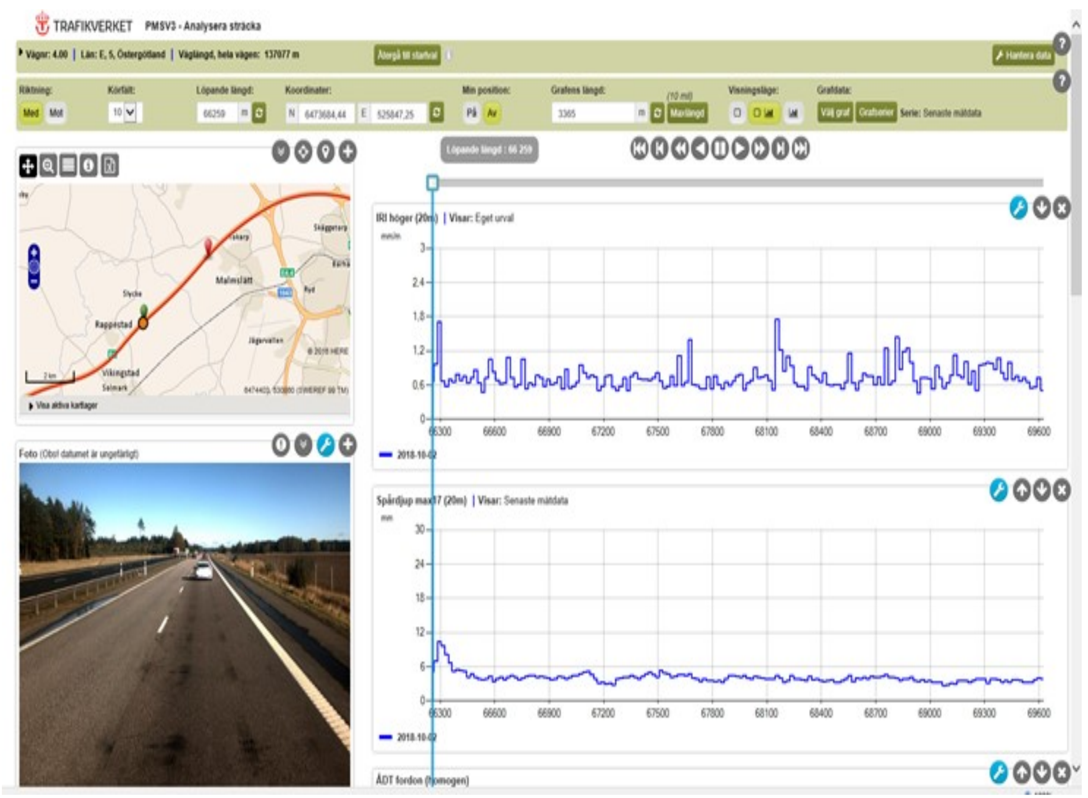

Figure 3. E4, IRI values.

The section, resurfaced in 2015, had an average IRI value around 0.8 mm/m.

According to Table 1, if a specified surface tolerance level of 10 mm (+ or -) is acceptable for track reinstatements, it is possible that IRI values could increase by up to 30%.

Maintenance Standards

Maintenance standards require that the maximum IRI value for this type of road and should not exceed 2.6 mm/m. In this example, IRI values would only increase to a maximum of 1.0 mm/m and would be well within the action level value prescribed in the standard.

According to Figure 4, vehicle speeds would not be affected by this increase in IRI unevenness.

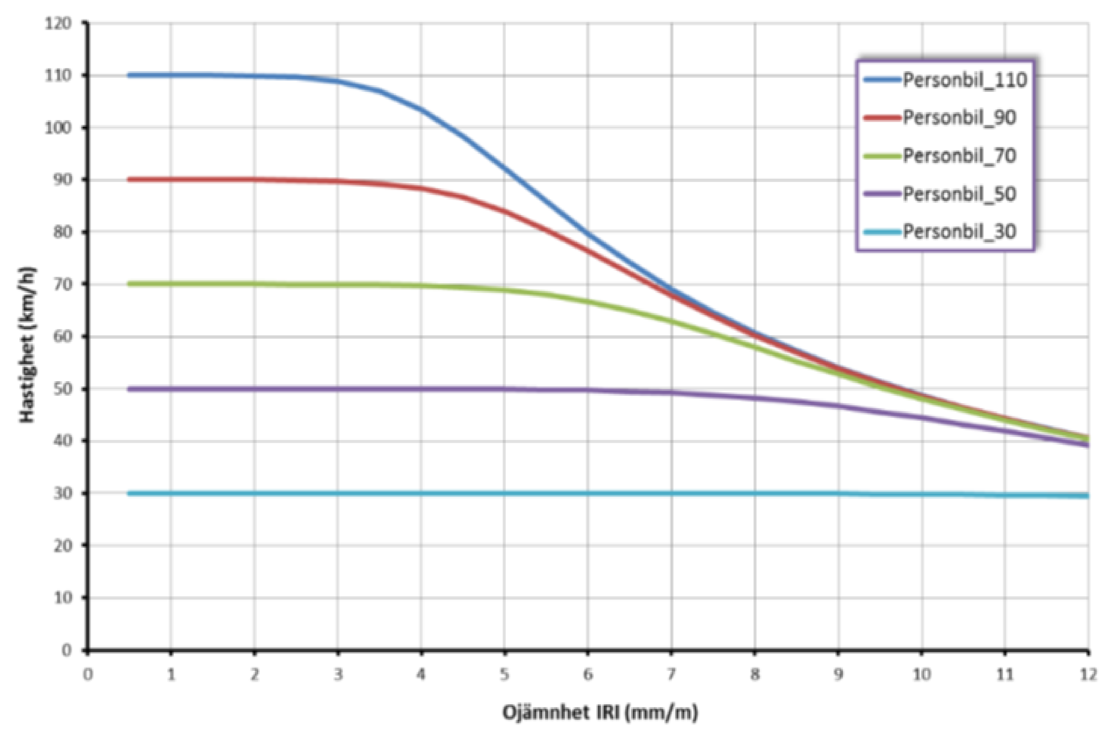

Figure 4. Relationship between vehicle speed and unevenness. Trafikverket, Effektsamband för transportsystem, 2017.

Comfort Levels

However, although IRI levels would still be within the prescribed standard, it is likely that the level of discomfort will increase. Driving over repetative road surface irregularities will influence the motorists perceived level of comfort. At a speed of 110 km/h, the local unevenness will be experienced every 3.2 seconds. If local unevenness adversely affects comfort levels, motorists will reduce speed until similar levels of comfort are experienced.

The results show that this type of surface irregularity is not accurately represented by current measurement standards. As measurements such as IRI are calulated over a longer length than the width of the irregularity, the uneveness effect will be averaged out over the length of the measurement unit.

Conclusion

The effect that local unevenness will have on comfort levels should be investigated further. To achieve this, levels of local unevenness must be quantifiable. Traditional unevenness measurment methods may not be suitable - the development and inclusion of a more appropriate road surface measurement standard is required.

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