Measurements of curve squeal from Oslo's subway

Sigmund Olafsen and Tore Killengreen

Brekke & Strand akustikk as, Hovfaret 17, N-0275 Oslo, Norway
so@bs-akustikk.no

Curve squeal from the subway line at Brattlikollen, Oslo, has led to severe noise complaints through the years. Two important steps have been taken to reduce the problem. An automatic rail lubrication system has been installed on the critical spot, and Oslo's old subway trains (1300 series) are being replaced. One of the new trains (MX) has also been fitted with wheel dampers. Continuous measurements during 16 days and nights with 2238 train passages have been analyzed to verify the effectiveness of these steps to reduce noise.

The main results can be summarized in short as follows:
1300 series trains without rail lubrication give severe curve squeal during 18% of the train passages. 1300 series trains with rail lubrication give severe curve squeal during less than 1% of the train passages. MX trains give substantially less curve squeal than 1300 series trains, with or without lubrication. The MX trains with wheel dampers give no curve squeal, even without lubrication.

1 Introduction

Curve squeal has been a persistent problem for residences alogn the subway line at Brattlikollen, Oslo. A procedure for manual lubrication of the rails has been in use for some years. The effect has been hard to document. Finally in august 2007 an automatic lubrication system was installed on the outbound track. This system distributes a controlled amount of a friction modifier after each passing train. At the same time a new type of subway trains was introduced. The old type is called the 1300 series, the new type is called MX 3000. The measurements were made in order to find out whether the introduction of a lubrication system and new trains would solve the problem of curve squeal.

For the purpose of the analysis of the measurements, curve squeal was defined as follows:

On the outbound track, trains giving an Lmax in the 3,15 kHz 1/3-octave band of more than 80 dB were considered to give curve squeal

On the inbound track, trains giving an Lmax in the 3,15 kHz 1/3-ocatve band of more than 74 dB were considered to give curve squeal.

For those who wonder why we bother about curve squeal from a subway, let's add that at least half of Oslo's "subway" network is above ground.

The measurements were made in order to check the effect of the lubrication system. This means that a microphone very close to the train will give a good indication of relative differences between train types and between lubricated and untreated rails.

2 The importance of curve squeal on Oslo's subway

The noise from rail/wheel interaction is a substantial contributor to the noise from Oslo's subways. There are several reasons for this.

- It runs at low to moderate speeds, 70 km/h maximum, in many places much slower, so aerodynamic noise is not much of an issue
- The power supply is from a rail running parallel to the track, thus there's no noise from an overhead power line.
- The whole system is on ballast track, so it doesn't have much of the structure-borne noise problem.

For these reasons the relative importance of curve squeal is greater than would normally be expected from a railway or a tram line.

3 Measurement setup

The measurement setup was quite simple. An outdoor microphone along the track was connected to a Norsonic 121 analyzer. The clock of the analyzer was synchronized with the system clock of the control center for the subways. Every time a subway train drives past a sensor in the track, the time of passage and the identity of the train is recorded by the control center.

20070918-PasseringBRATLIKOLLEN

Train	Type of train	Cars	No. of cars	To	A/D	Date and time	Platform
405	13xx	1302, 1348, 1338	3	MJ3X	A	18.09.2007 00:17	BRA2
407	MX	3014	3	BKR1	A	18.09.2007 00:28	BRA1
407	MX	3014	3	RYE1	A	18.09.2007 00:42	BRA2
405	13xx	1323, 1349, 1339	3	BKR1	A	18.09.2007 05:43	BRA1
404	13xx	1302, 1348, 1338	3	NYD2	A	18.09.2007 05:48	BRA2
406	13xx	1306, 1346, 1322	3	BKR1	A	18.09.2007 05:58	BRA1
405	13xx	1323, 1349, 1339	3	NYD2	A	18.09.2007 06:04	BRA2
407	MX	3014	3	BKR1	A	18.09.2007 06:15	BRA1
406	13xx	1306, 1346, 1322	3	NYD2	A	18.09.2007 06:18	BRA2
408	13xx	1307, 1347, 1321	3	BKR1	A	18.09.2007 06:28	BRA1
407	MX	3014	3	NYD2	A	18.09.2007 06:34	BRA2
409	13xx	1343, 1342, 1325	3	BKR1	A	18.09.2007 06:44	BRA1
408	13xx	1307, 1347, 1321	3	NYD2	A	18.09.2007 06:48	BRA2
107	T2000	2003, 2008	2	BKR2	A	18.09.2007 06:51	BRA1
401	MX	3011	3	BKR1	A	18.09.2007 06:58	BRA1
409	13xx	1343, 1342, 1325	3	NYD2	A	18.09.2007 07:03	BRA2
402	MX	3015	3	BKR1	A	18.09.2007 07:13	BRA1
401	MX	3011	3	NYD2	A	18.09.2007 07:18	BRA2
108	13xx	1312, 1311	2	BKR2	A	18.09.2007 07:22	BRA1
107	T2000	2003, 2008	2	FR82	A	18.09.2007 07:26	BRA2
403	13xx	1333, 1309, 1310	3	BKR1	A	18.09.2007 07:28	BRA1
402	MX	3015	3	NYD2	A	18.09.2007 07:34	BRA2
109	13xx	1316, 1315	2	BKR2	A	18.09.2007 07:35	BRA1
108	13xx	1312, 1311	2	FR82	A	18.09.2007 07:41	BRA2
404	13xx	1302, 1348, 1338	3	BKR1	A	18.09.2007 07:43	BRA1
403	13xx	1333, 1309, 1310	3	NYD2	A	18.09.2007 07:48	BRA2
101	13xx	1319, 1329	2	BKR2	A	18.09.2007 07:50	BRA1
109	13xx	1316, 1315	2	FR82	A	18.09.2007 07:56	BRA2
405	13xx	1323, 1349, 1339	3	BKR1	A	18.09.2007 07:59	BRA1
404	13xx	1302, 1348, 1338	3	NYD2	A	18.09.2007 08:03	BRA2
102	13xx	1305, 1308	2	BKR2	A	18.09.2007 08:08	BRA1
101	13xx	1319, 1329	2	FR82	A	18.09.2007 08:11	BRA2
406	13xx	1306, 1346, 1322	3	BKR1	A	18.09.2007 08:15	BRA1
405	13xx	1323, 1349, 1339	3	NYD2	A	18.09.2007 08:17	BRA2
103	13xx	1326, 1328	2	BKR2	A	18.09.2007 08:21	BRA1
102	13xx	1305, 1308	2	FR82	A	18.09.2007 08:26	BRA2
407	MX	3014	3	BKR1	A	18.09.2007 08:29	BRA1
406	13xx	1306, 1346, 1322	3	NYD2	A	18.09.2007 08:33	BRA2
103	13xx	1326, 1328	2	FR82	A	18.09.2007 08:41	BRA2
408	13xx	1307, 1347, 1321	3	BKR1	A	18.09.2007 08:44	BRA1
407	MX	3014	3	NYD2	A	18.09.2007 08:48	BRA2
409	13xx	1343, 1342, 1325	3	BKR1	A	18.09.2007 08:58	BRA1
408	13xx	1307, 1347, 1321	3	NYD2	A	18.09.2007 09:03	BRA2

Figure 1 Sample of records from the control center of trains passing the microphone

The analyzer was set to measure Leq and Lmax, FAST, in 1/3-octave bands and A-weighted every second. The choice of one second intervals was made from practical considerations. The use of a finer time resolution would lead to a possible loss of maximal levels. With a coarser time resolution, the passage of a train might be missed.

The values during a passage were analyzed as follows: The SEL level of a passage is the sum of 1-second Leq's, the MAX level of a passage is the highest level in each individual band. The A-weighted maximal level from the subways will usually be lower that the A-weighted sum of maximal levels in 1/3-octave bands, as the events giving the highest level in each band do not occur at the same time.

Period: Time: Duration: LAeq LAF(max) LfF(max)

Period	Time	LAeq	LAF(max)	3.15 Hz	4.0 Hz	5.0 Hz	6.3 Hz	8.0 Hz	10 Hz	12.5 Hz	16 Hz	20 Hz	25 Hz	31.5 Hz	40
291	(2007-09-12 09:58:32.030)	57,6	59,0	38,3	50,4	50,2	44,7	51,1	50,3	53,6	54,9	56,7	58,2	59,3	62
292	(2007-09-12 09:58:33.030)	62,7	65,4	46,8	45,0	48,2	43,5	51,7	50,8	57,1	59,6	59,1	60,1	58,7	61
293	(2007-09-12 09:58:34.030)	68,6	69,8	49,1	44,7	44,9	41,4	49,7	54,6	58,0	59,3	65,7	63,7	61,7	67
294	(2007-09-12 09:58:35.030)	68,0	69,3	44,2	43,3	49,1	48,1	46,2	57,2	58,4	60,7	65,1	70,9	64,4	67
295	(2007-09-12 09:58:36.030)	65,4	67,2	45,1	44,0	48,0	50,1	49,6	53,7	55,5	66,2	64,5	67,5	62,2	70
296	(2007-09-12 09:58:37.030)	65,3	65,7	49,0	43,5	47,4	51,3	50,4	55,1	55,3	54,6	55,1	65,7	59,7	65
297	(2007-09-12 09:58:38.030)	64,6	65,5	45,7	41,0	47,5	52,0	49,3	50,3	52,3	58,9	56,0	62,4	61,4	60
298	(2007-09-12 09:58:39.030)	63,5	64,3	40,1	46,2	48,1	51,3	50,3	52,1	51,9	58,3	54,3	58,8	62,0	66
299	(2007-09-12 09:58:40.030)	62,8	64,3	44,9	48,7	47,7	42,5	49,3	52,9	51,1	57,2	54,8	55,0	60,1	66
300	(2007-09-12 09:58:41.030)	61,9	62,7	44,2	45,5	48,1	47,5	49,2	51,9	53,5	56,2	60,2	52,1	58,7	73
301	(2007-09-12 09:58:42.030)	62,5	63,0	49,9	43,7	48,5	48,5	49,5	52,4	50,8	54,2	59,6	55,5	65,9	70
302	(2007-09-12 09:58:43.030)	64,1	64,9	49,5	44,5	48,9	46,8	46,6	48,6	55,3	51,2	59,5	57,8	62,5	65
303	(2007-09-12 09:58:44.030)	67,0	67,8	46,8	51,0	53,7	59,4	61,8	64,5	65,1	63,4	64,6	60,5	63,5	66
304	(2007-09-12 09:58:45.030)	66,4	67,4	53,1	54,4	57,0	60,5	62,0	64,8	63,2	61,8	65,2	59,8	60,8	66
305	(2007-09-12 09:58:46.030)	66,4	69,2	50,1	53,9	53,2	53,2	50,9	57,1	62,2	61,1	64,1	65,4	62,4	69
306	(2007-09-12 09:58:47.030)	61,5	64,8	46,4	47,7	53,0	50,7	50,7	55,2	56,2	64,1	61,1	60,5	61,1	66
307	(2007-09-12 09:58:48.030)	62,8	64,1	47,7	50,4	50,9	54,1	53,9	60,6	59,7	71,5	63,2	62,6	63,6	70
308	(2007-09-12 09:58:49.030)	70,9	74,6	51,7	50,2	49,0	54,2	53,5	59,5	62,0	66,8	66,8	60,2	61,5	69
309	(2007-09-12 09:58:50.030)	76,9	78,8	47,7	50,1	50,5	52,0	52,4	57,1	61,9	63,8	64,2	60,4	59,0	64
310	(2007-09-12 09:58:51.030)	69,9	74,2	42,2	49,7	49,3	52,9	52,1	61,8	59,0	58,7	63,2	63,4	63,0	65
311	(2007-09-12 09:58:52.030)	68,2	69,1	45,2	52,3	45,2	55,4	51,1	62,5	55,3	58,1	58,7	57,7	53,9	63
312	(2007-09-12 09:58:53.030)	65,7	67,5	41,4	52,2	48,4	54,0	52,9	57,5	52,4	54,5	56,5	57,0	55,0	61
313	(2007-09-12 09:58:54.030)	64,9	65,5	40,3	42,2	47,0	50,1	49,2	51,0	50,6	52,8	57,0	53,0	53,1	58
314	(2007-09-12 09:58:55.030)	63,3	64,5	40,0	42,0	47,7	44,8	49,1	49,3	54,3	51,7	54,5	54,2	53,1	60
315	(2007-09-12 09:58:56.030)	61,7	62,7	40,1	41,9	42,6	45,8	47,7	46,5	48,7	50,6	53,0	52,9	55,9	59
316	(2007-09-12 09:58:57.030)	60,3	61,0	38,8	46,8	41,4	48,8	51,3	51,2	53,1	48,8	51,9	51,3	52,4	54
1483	(2007-09-12 10:18:24.030)	61,3	63,4	55,6	61,3	54,3	54,2	53,0	57,0	59,5	60,2	54,8	57,6	63,3	59
1484	(2007-09-12 10:18:25.030)	60,0	61,1	66,6	69,2	75,1	67,8	65,4	66,9	60,3	61,2	60,1	57,4	63,2	60
1485	(2007-09-12 10:18:26.030)	58,9	59,3	66,9	69,1	75,4	68,1	63,8	64,2	64,6	61,0	55,9	58,8	63,5	58
1486	(2007-09-12 10:18:27.030)	59,4	59,9	58,6	64,5	63,6	59,2	57,9	55,4	59,7	55,5	52,7	59,9	63,5	57
1487	(2007-09-12 10:18:28.030)	61,3	62,9	57,3	54,1	54,5	54,0	54,6	56,7	57,6	55,2	56,8	60,3	65,4	64
1488	(2007-09-12 10:18:29.030)	65,7	67,8	64,2	65,9	63,8	52,3	60,7	64,8	60,4	58,7	63,6	65,9	67,8	65
1489	(2007-09-12 10:18:30.030)	70,3	71,2	71,9	68,0	64,9	64,6	64,5	63,6	62,0	61,4	61,4	67,0	72,7	72
1490	(2007-09-12 10:18:31.030)	72,5	73,0	72,2	69,3	65,0	62,6	64,0	60,6	62,3	66,0	65,4	66,1	68,4	69
1491	(2007-09-12 10:18:32.030)	73,4	73,8	69,9	61,9	62,1	63,2	58,1	64,5	64,7	66,6	64,1	62,7	69,9	70
1492	(2007-09-12 10:18:33.030)	73,2	74,0	65,7	55,5	62,0	58,3	65,3	64,7	67,3	66,0	65,6	65,5	69,8	72
1493	(2007-09-12 10:18:34.030)	72,6	73,4	64,7	57,9	63,4	64,8	65,7	65,1	67,2	63,2	64,2	65,2	70,7	71
1494	(2007-09-12 10:18:35.030)	72,1	73,7	61,1	60,0	60,9	67,9	64,4	65,8	66,4	65,2	65,8	67,5	69,3	73
1495	(2007-09-12 10:18:36.030)	70,9	71,4	59,7	62,2	61,7	68,0	58,6	61,9	69,4	62,5	64,4	65,3	67,6	73
1496	(2007-09-12 10:18:37.030)	68,8	71,4	56,1	56,9	54,2	54,0	59,3	61,6	65,9	59,7	59,6	62,4	67,2	69
1497	(2007-09-12 10:18:38.030)	65,0	66,8	59,1	57,3	58,7	55,3	59,2	61,6	66,9	55,4	56,4	59,6	64,1	67
1498	(2007-09-12 10:18:39.030)	62,3	64,0	60,1	56,6	56,9	59,5	53,6	58,4	62,4	55,9	57,4	58,5	65,5	64
1499	(2007-09-12 10:18:40.030)	62,1	64,9	58,2	55,3	60,4	58,6	53,7	56,7	55,5	58,6	56,6	58,5	65,3	60
1500	(2007-09-12 10:18:41.030)	59,5	62,1	61,7	60,5	62,3	61,1	58,9	54,4	55,8	59,0	54,5	55,7	64,2	58
1501	(2007-09-12 10:18:42.030)	60,7	61,4	61,2	67,3	62,5	63,6	57,7	55,4	59,2	58,6	57,7	59,8	63,6	56
1502	(2007-09-12 10:18:43.030)	62,2	65,1	56,1	64,9	62,5	59,7	56,0	54,2	50,9	51,2	54,7	56,4	64,2	57
2427	(2007-09-12 10:34:08.030)	57,9	59,6	46,5	50,2	53,2	58,8	53,6	58,3	58,8	53,8	60,9	60,1	61,8	61
2428	(2007-09-12 10:34:09.030)	61,6	63,5	52,8	50,3	59,1	60,0	56,7	61,7	57,8	58,9	59,5	64,0	62,8	65
2429	(2007-09-12 10:34:10.030)	65,0	66,4	54,4	55,8	55,0	51,2	55,0	62,0	57,2	58,4	59,6	61,2	60,7	63
2430	(2007-09-12 10:34:11.030)	68,3	69,4	52,2	55,9	53,3	52,5	52,9	62,4	55,2	56,6	62,2	63,1	65,0	68
2431	(2007-09-12 10:34:12.030)	70,1	70,7	44,2	51,9	46,2	47,4	55,7	59,4	61,1	58,1	64,2	64,5	68,1	69
2432	(2007-09-12 10:34:13.030)	71,4	72,3	47,4	50,3	46,0	52,1	54,3	64,0	61,7	63,6	64,2	65,4	70,0	73
2433	(2007-09-12 10:34:14.030)	71,7	72,2	52,4	52,4	51,0	53,9	52,4	64,1	59,5	58,5	61,9	66,5	70,5	74
2434	(2007-09-12 10:34:15.030)	71,1	72,1	52,4	53,4	52,9	56,1	58,0	63,2	59,9	64,6	65,5	66,4	69,1	74
2435	(2007-09-12 10:34:16.030)	72,0	72,9	46,7	43,8	50,8	51,0	58,1	66,1	60,2	59,5	66,0	67,8	69,2	70
2436	(2007-09-12 10:34:17.030)	71,5	72,6	49,8	45,5	51,5	49,4	54,4	67,7	59,6	63,4	61,1	66,1	67,2	68
2437	(2007-09-12 10:34:18.030)	69,6	71,9	51,4	47,9	48,0	51,2	55,9	65,2	58,5	61,4	62,4	64,5	68,7	69
2438	(2007-09-12 10:34:19.030)	66,4	70,2	50,4	49,5	53,1	52,4	55,8	63,0	60,0	57,9	57,6	62,7	66,9	68
2439	(2007-09-12 10:34:20.030)	61,2	63,7	52,0	56,7	63,6	65,9	64,7	62,9	54,9	58,3	56,2	58,5	67,0	64
3098	(2007-09-12 10:45:19.030)	58,9	61,0	59,5	63,5	58,0	58,4	58,0	52,6	53,9	58,2	60,3	57,7	58,5	59
3099	(2007-09-12 10:45:20.030)	62,0	66,2	61,6	56,7	57,6	58,3	59,0	62,0	61,1	56,6	55,4	54,1	60,7	61
3100	(2007-09-12 10:45:21.030)	65,4	67,6	60,0	59,5	58,4	56,1	58,1	61,6	59,3	54,9	57,0	57,4	56,9	61
3101	(2007-09-12 10:45:22.030)	68,6	70,8	55,4	58,1	54,9	50,6	50,3	54,0	54,0	55,8	57,6	56,9	60,4	63

Figure 2 Sample of the output file from the analyzer after removing the periods without trains passing

A passage of a subway train has a duration of 5-6 seconds. The measured data were scanned manually to look for possible passages. If a possible train passage was found, the time was checked against the records of the control center.

A total of 2238 events were accepted as valid passages of subway trains.

At the time of the measurements, the Norsonic 121 used was not set up to make sound recording during train passages. The measurement was expected to go on for a couple of weeks, so continuous recording was not possible either due to insufficient data storage capacity. It's thus not possible to make any finer frequency resolution than the 1/3-octave bands reported in this paper.

The microphone was placed 1,2 meters above the railhead on a bridge with ordinary ballast track. It was mounted at a horizontal distance of 1,8 meters from the nearest rail, 2,7 meters from the centre line of the outbound track. It was 6,7 meters away from the centre line of the inbound track.

A standard Norsonic microphone was used with the Norsonic outdoor microphone protetction.

4 Train types

There are two types of trains constituting the great majority of trains running on Oslo's subways. The 1300 series have been around for up to 40 years, they're worn, and the cars do not run in fixed train sets.

Figure 3, 1300 series train

Taken from Wikipedia

© 2005 J. P. Fagerback

The MX 3000 trains, on the other hand, are brand new, some of them practically unused. They always run the same 3 cars in fixed sets, and with the number of passages recorded it was possible to evaluate the noise from each set. One of the MX 3000 sets had wheel dampers.

Figure 4, MX 3000 train

Taken from Wikipedia, Photo: Kjetil Ree (Creative Commons Attribution Sharealike 3.0)"

5 Lubrication system

The automatic lubrication system on the outbound track was supplied by Kelsan. The inbound track is lubricated manually.

Fig.5 Lubrication system and the curve which has led to noise problems.

6 Effect of lubrication, all types of train

Analysis was performed separately for three cases:

1. Outbound track, lubrication system running (468 trains, 4 with curve squeal)

2. Outbound track, lubrication system not running (657 trains, 119 with curve squeal)

3. Inbound track (1113 trains, 27 with curve squeal).

6.1 Outbound track, with automatic lubrication

The maximal level spectra of the 4 trains giving the highest LA,max levels are shown below.

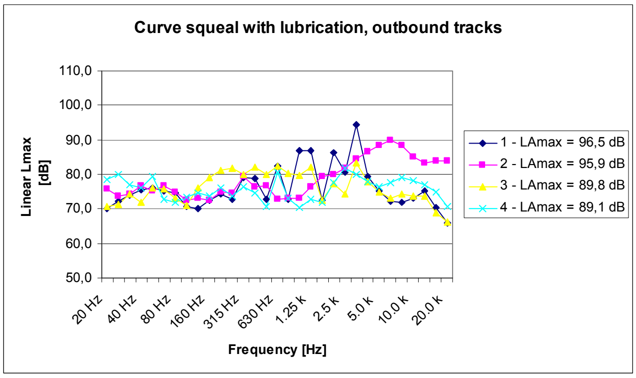

Fig.6 Curve squeal, 4 highest levels with lubrication system running.

There's only one train passage that gave the 3,15 kHz peak so typical of the critical curves of Oslo's subway network. This was an old 1300 series train.

6.2 Outbound track, without lubrication

The maximal level spectra of the 5 trains giving the highest LA,max levels are shown below.

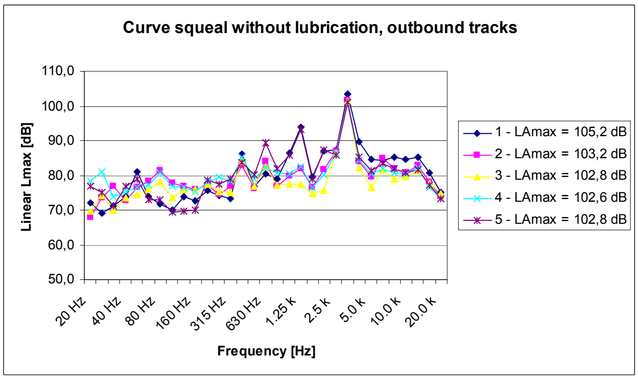

Fig.7 Curve squeal, 5 highest levels without lubrication system running.

The peak in the 3,15 kHz 1/3-octave band is very pronounced for the noisiest trains. The A-weighted maximal levels are extremely high, above 100 dB, and the squeal is a severe problem even indoors.

6.3 Inbound track

The inbound track is lubricated manually. The maximal level spectra of the 5 trains having the highest LA,max level are shown below.

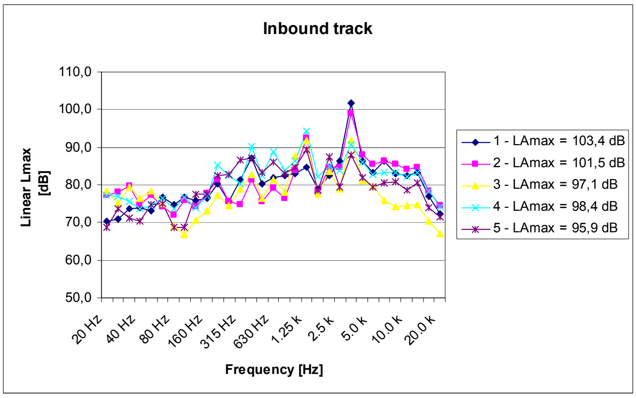

Fig. 8 Curve squeal, 5 highest levels with on inbound track.

It seems that the routines for manual lubrication occasionally fail, so that extremely noisy events occur. Note the peak at 3,15 kHz.

7 Effect of lubrication, comparison between train types

The amount of data allowed us to compare the different train types on the outbound track. In table 1 below the energy average of A-weighted SEL and MAX levels

Train type	LAmax (dB)	SEL,A (dB)
MX 3000 with lubrication	81,5	86,5
MX 3000 without lubrication	89,0	92,9
1300 series with lubrication	85,1	88,0
1300 series without lubrication	94,6	96,8

Table 1, effect of lubrication

So, the MX 3000 series is quieter both with and without lubrication than the 1300 series. Actually curve squeal was not observed from any of the MX 3000 passages with lubrication.

8 Variation between train sets

The 1300 series do not run in fixed train sets, so we haven't tried to analyze the noise from individual cars. For the MX trains it was actually possible to check for differences between the train sets. The set named 3002 was fitted with wheel dampers, and it was an important question whether the wheel dampers had any positive effect on noise.

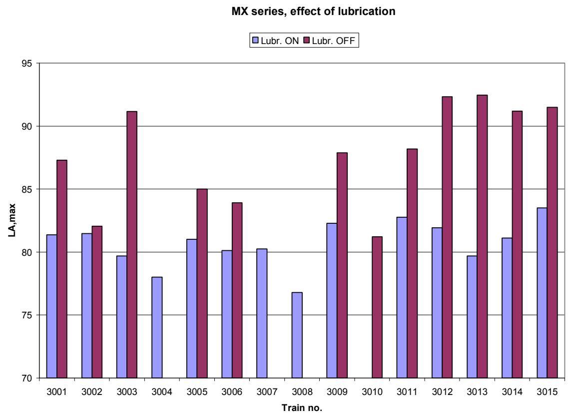

Figure 9, effect of lubrication for MX trains

Figure 9 shows the difference between measured values for LA,max with and without lubrication. The individual trains run on different parts of the subway from day to day. Thus not all of the MX trains have been measured with and without lubrication.

The 3002 train set had wheel dampers fitted. It seems that lubrication has little effect on this train. On the other trains, it's obvious that lubrication of the rails has a substantial effect.

9 Conclusion

Curve squeal has been a severe problem at certain locations in Oslo's subway network. Maximal levels of up to 90 dB in the 3,15 kHz 1/3-octave band have occurred at the façade of some residences.

The proportion of curve squeal events have been reduced from 18% of the trains to less than 1% of the trains with the automatic lubrication system running.

The automatic lubrication system reduces maximal sound levels in the 3,15 kHz 1/3-octave band by about 10 dB.

The MX 3000 trains give substantially less curve squeal than the older T1300 series. No MX 3000 train has given rise to curve squeal with the automatic lubrication system running.

The MX 3000 train set 3002 with wheel dampers has not given rise to curve squeal, even without rail lubrication.

The MX 3000 series trains are quieter than the T1300 series, with or without lubrication, with or without wheel dampers.

Acknowledgments

First of all our sincere thanks to Kollektivproduksjon AS, the company that runs Oslo's subways (as well as the trams and many of the buses). This company commissioned the measurements and permitted us to publish the results. And thanks to our internal project manager, Atle Stensland, who couldn't come to Paris to present the results. Last but not least thanks to Mona Bech who found the passages of the subway trains among 1,4 million lines of data.

Figures 1 and 2 are taken from Wikipedia. These photos may be distributed as long as the original photographer is credited.