The InterCity Initiative – railway development in Norway

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Summary
In Norway there is a great amount of major railway projects planned, called The InterCity initiative. This development has its focus in the southeastern part of Norway and includes 25 stations and 270 km of new double track, which will give 1.5 million residents and commuters faster journeys and an increased amount of departures.

To ensure optimized projects and make sure that noise annoyance in the neighborhoods near these InterCity projects is as low as possible, a group of consultants is working together with the Norwegian railway infrastructure manager, Bane NOR.

The Nordic prediction method for railway noise is the most common method used for noise mapping in Norway. This method was last updated in 1996, therefore, it's rather limited when it comes to considering effects of new measures. To make sure that noise issues are handled in the same way in different projects and in different parts of the country, the group of consultants holds regularly meetings. In addition to discussing challenges due to the prediction method and necessary adaptations to data tools, interpretation of regulations is discussed. Important issues include:

- Will new low noise trains compensate for the increase in the number of trains?
- Is it always best to be conservative and assume worst case when it comes to noise?
- What about the costs, will noise reduction measures always be wanted?
- Is it necessary to look at specific houses, or have more focus on an area as a whole?

Following, decisions are made that all the participants must apply in ongoing projects. Another positive effect of this approach is that it has contributed to changes in the technical regulations for new main railway tracks in Norway.

To illustrate this approach in practice, we will present specific examples of ongoing projects.

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1. Introduction

The Norwegian railway infrastructure manager, Bane NOR, is a state-owned company that has the responsibilities to plan and build new railway infrastructure in Norway. Bane NOR is responsible for a number of the country's biggest public transport projects, such as the development of The InterCity Initiative, the Follo Line and joint Ringerike Line and E16 project. [1]

The development of The Intercity Initiative has its focus in the southeastern part of Norway and includes 25 new stations and 270 km of new double track, which will give 1.5 million residents and commuters faster journeys and an increased amount of departures. For Oslo and the central part of eastern Norway the expectation is a strong population growth over the next few decades. Significant improvement of rail services on the InterCity network will play an important part in relieving the pressure om the capital city and in the

development of the areas where people live and work along the InterCity sections.
Norway is quite a large country with 5.3 million inhabitants. There are a lot of mountains and settlements are scattered in the country. The highest population density is in the southeastern part, in the area around Oslo. With less urban density than most other countries in Europe, noise measures along and in the tracks will often be relatively expensive compared to the number of people who benefit from the measure. This means that a lot of resources are being used for noise calculations and optimization of noise reduction measures in the field of transport projects.

The figure below shows a map of Norway, the red square indicates where the InterCity lines are located.

Figure 1. Map of Norway.

There is a great amount of development due to the railway system in Norway these days as major projects are being planned. It is very exciting but also challenging to work with engineering and planning to ensure good projects and good community development. As acoustic consultants we contribute to ensure optimised projects and make sure that noise annoyance in the neighbourhoods near these InterCity projects will be as low as possible.

2. Framework

The question is how to appraise the occurring noise levels in relation to the desired use in an area nearby noise sensitive buildings or as a tranquil area. For that we can make use of the legal framework, but also more qualitative factors are important.

Since 2005 a guideline for handling noise in relation to land use planning (Retningslinje for behandling av støy i arealplanlegging), T-1442, is implemented in Norway [2]. In this guideline different situations regarding noise are described, mostly related to development of new sources or new receiver areas. What levels are perceived as annoying depends on the type of area you are in, and the use of the area that is desirable. This guideline has however no legal status until it is part of a zoning plan.

In T-1442 you will find a list with recommended noise levels for different types of areas. When there is a plan for establishment of a new project, this table provides a guideline for the use of noise limits for different type of areas. You can also use it to match an occurring noise level to a possible land use.

Table I. Recommended noise level limits on outdoor area and outside windows to room with noise-sensitive purpose of use.

Noise source	*Recommend noise limits*	*Outside bedroom, at night 23 - 07*
Railway	L_{den} 58 dB	L_{5AF} 75 dB

Table II. Recommended noise limits in the various types of outdoor and recreational areas.

Area	*Recommend noise limits* L_{DEN}
Urban parks and other recreation areas	55 dB
Hiking trails, city parks, cemetery	50 dB
Local recreational areas, near sea and rivers	40 dB

When establishing new noisy activities, or noise sensitive buildings are placed near a noise source, the effect of the noisy activities in these areas should be made visible.

3. The planning process

When it comes to the planning and engineering part of a new railway project, there are several stages of development and different levels of detailing to relate to.
All new railway infrastructure projects in Norway must be planned according to an official planning process. This planning process is divided into different steps, and the main steps are as described below. The figure illustrates this planning process.

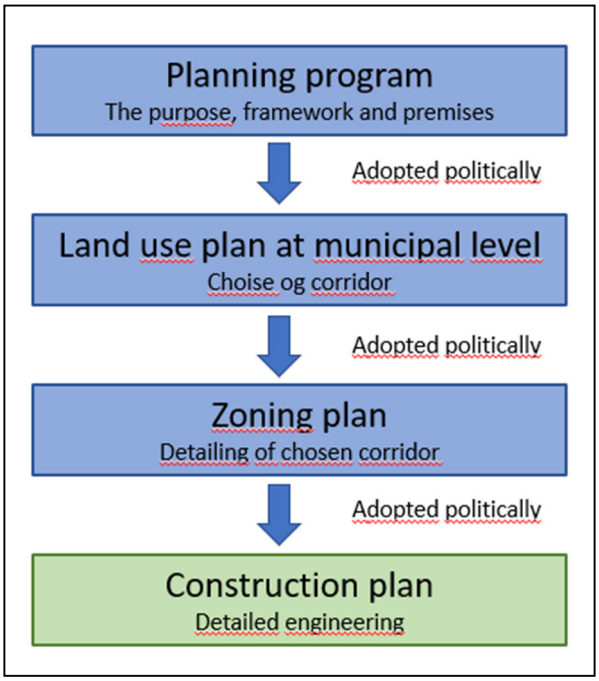

Figure 2. Planning process.

3.1. Planning program

The planning program is a “plan for the planning”. It provides the purpose, framework and premises for the further work. The proposal for the planning program is prepared by Bane NOR, normally with assistance of consultants, while it is the politicians in the affected municipality that eventually approves the planning program.

3.2. Land use plan at municipal level

This plan contains general principles for the future development and includes decisions for the choice of corridor for the future railway track. This phase also includes investigation of consequences of one corridor compared to another, both in terms of priced and non-priced consequences. Examples of a non-priced consequence is outdoor activities and natural resources. Noise assessments are often included in both categories. The cost of noise reduction measures is to be included in the cost analysis, while the noise in a community or in a recreation area is seen as a non-priced consequence. All consequences for an option are collected for a comprehensive assessment and to provide a complete overview. Bane NOR prepares proposals for the land use plan, normally with assistance of consultants, while it is the politicians in the affected municipality that eventually approve the plan.

3.3. Zoning plan

In this plan, the contents of the municipality plan will be further detailed, based on one selected corridor. As the guideline T-1442 has no legal status until it is part of a zoning plan, this is an important task to further implementation of the project. In most projects, the recommended noise limit is used. It is possible to deviate from the recommended noise limit when other considerations make it appropriate, but this must be described and adopted in the zoning plan.
Bane NOR prepares proposals for a land use plan, normally with assistance of consultants, while it is the politicians in the affected municipality that eventually approve the plan.

In parallel with the public planning process, a technical plan will be undertaken for the measure.

3.4. Construction plan with detailed engineering

Once the zoning plan is approved by politicians, the work to detail all technical matters according

to the project starts. This includes all engineering work that is necessarily to be completed before the entrepreneurs starts up with the construction work on site.

As consultants in acoustics and noise control we take place in all these phases. The work starts with overall analyses and gets more detailed throughout the planning process.

4. Communication and cooperation with Bane NOR

4.1. The Nordic prediction method for railway noise

The Nordic prediction method for railway noise [3] is the most common method used for noise mapping in Norway. The origin is back to the days when the engineers did their calculations with use of paper and a pencil. This method was last updated in 1996, therefore, it is rather limited when it comes to considering effects of new measures. This calculation method has some weaknesses, yet it is an approved method and ensures uniform handling of various assignments.

4.2. Results from the meetings of the consultants group

To ensure optimised projects and to make sure that noise annoyance in the neighbourhoods near these InterCity projects is as low as possible, a group of consultants is working together with Bane NOR. To make sure that noise issues are handled in the same way in different projects and in different parts of the country, the group of consultants holds regularly meetings. In addition to discussing challenges due to the prediction method and necessary adaptations to data tools, interpretation of regulations is discussed.

Following, decisions are made that all the participants must apply in ongoing projects. Another positive effect of this approach is that it has contributed to changes in the technical regulations for new main railway tracks in Norway. Many of these decisions are implemented in the Technical design basis for the InterCity Initiative [4]. Technical design basis for InterCity has been developed to ensure standardized and appropriate solutions for the railways in the InterCity area. It has become a common platform that ensures that the individual subprojects make their decisions on the same basis.

Some of the topic discussed are described below:

- To calculate noise maps normally all consultants in Norway use different kind of computer software. In order to standardize the level of detailing, there has been agreement on a recommended grid resolution.

- The Nordic prediction method does not include handling of noise from tunnel portal. How to handle this has been discussed, but no standardized method is established yet.

- In order to compare calculation results for different railway lines, the calculation height should be equivalent. There is a consensus on calculate both at 4 meters and 1,5 meters height above ground level. The noise limits in T-1442 are applicable for 4 meters, but 1,5 meters above ground level better shows the effect of shielding outdoor areas, using noise screens.

- New trains (rolling stock?) mean new noise emission data. A significant change recently is emission data for freight trains, with new brake systems implementing composite blocks. The difference is in the range of 7 – 10 dB. In Norway it is not decided yet if or eventually when it will be introduced a ban on cast iron blocks. On lines of mixed traffic, freight trains will often dominate the noise picture. That is why it is important to be aware of which trains will traverse the track in the future and that the correct noise emission data will be used. To perform calculation with old or new noise emission from freight trains, may have a big impact on noise propagation.

- Speed through station areas for both trains that stop, and non-stop trains is another topic that has been discussed. The Nordic prediction method does not include noise caused by acceleration and retardation at station areas. To calculate with some extra noise in this area, it is assumed that stopping trains run at a certain minimal speed through the station area. The speed is often set to 50 km/h.

- Noise limits are given as integer values, while the calculation programs calculate by at least one decimal place. Rounding rules for noise limits have therefore been discussed. The decision is based on what is otherwise regular rounding rules in Norway. That is to say that for the noise limit L_{den} 58 dB, a calculated value of 58,4 will be rounded down to 58 dB and is acceptable, while

58,5 dB will be rounded up to 59 dB and thus exceeds the noise limit.

- Optimized track design and preventative maintenance may reduce noise emissions from rail traffic. There is little data in Norway on track quality and impact on level from rail traffic, it is therefore agreed on not to take into account any possible correction for good track quality at this time.

- Noise contribution from railroad switch is known as a problem for neighbours close to railway tracks, where switches are placed. The prediction method has implemented an additional noise contribution from switches, but when calculating an equivalent level, this additional noise contribution does not match the experience nuisance for the neighbours. Research has been done to look at an alternative approach for this with focus on the characteristic of this type of noise source. In Norwegian regulations it is normal to sharpen the limits of noise with impulse character with 5 dB. Within a range from the switch, based on the sound propagation of the max level by passing a switch, it should be considered to sharpen the noise limit as for noise sources with impulse sound characteristics. This may ensure more extensive noise reduction measures and as a result the noise annoyance in homes will decrease significantly. This has not been tested on a large scale yet but has put the spot on increased costs to reduce noise from traditional railroad switches. Using jointless switches is far less noisy, and less other noise reduction measures will be necessary in the neighbourhood. Such a focus on the annoyance for regular switches increases the ability to influence the choice of noise-sensitive alternative when building a new railway track.

These meetings and discussions in the group of consultants and Bane NOR have also led to that other important issues and questions are raised:

- In what extent will new low-noise trains in the future compensate for the increase in the number of trains?
  - This is especially relevant these days in the case of freight trains. How to ensure a good and relevant correction in the prediction method for freight train with composite blocks?
- Is it always best to be conservative and assume worst case when it comes to noise and will noise reduction measures always be wanted?
  - Due to the fact that the prediction method is old and the data to some extent is expired, normally the calculation results will be conservative and the simulated noise exposure higher than measurements shows after completing the construction.
  - When calculating worst case-situations it may be recommended to build a larger amount of noise barriers than actually required. This is not only to the best since noise screens causes barrier effect in a local area, may shade to the sun, etc. For travellers, noise barriers will reduce the view and thus a poorer travel experience.
  - When calculating higher noise levels outside a building it may cause more measures and more comprehensive measures in facades, which in turn leads to greater intervention in people's homes. In addition to greater costs.

- Making measures in the track to reduce noise emission is a good idea instead of using barriers and so on. As an example, rail grinding is an effective way to prevent and reducing both wear and traffic noise. For the moment, this is not widely used in Norway. One challenge is that this entails increased construction costs and / or maintenance costs. Since relatively few people are living along the railroad in Norway, the cost per noise-exposed neighbour will be relatively large in comparison with similar measures in other countries with more densely populated areas. We are only a few to share the cost.

- Is it really necessary to look at specific houses when it comes to noise reduction measures? Or could it be better to have more focus on an area as a whole? This would ensure more equal treatment and will take into account the uncertainties that lie in the prediction method and the noise emission data. Our experience indicates that this is normally only considered for apartment blocks, but not for residential areas. In our opinion this is something that should be considered more.

5. The InterCity initiative – Vestfold Line

To illustrate this approach in practice, we will present specific examples from an ongoing project, the section named Drammen – Kobbervikdalen, at the Vestfold line. In December 2016 it was decided where the new track should be placed, and

Bane NOR prepared a zoning plan. This was published for public inspection December 2017, with consultation deadline February 2018. Today the construction plan and detailed engineering is being performed by the engineering team together with Bane NOR.

5.1. Modernization of the Vestfold line

The Vestfold line is being modernized in order to reduce travel times and increase capacity. To attract travellers, the railway needs to shorten travel times, increase train frequency, improve punctuality, and needs to have centrally located stations. According to the Norwegian National Transport Plan for 2018-29, continuous double tracks must be completed from Oslo to Tønsberg in 2024, and to Skien in 2032. Several sections have already been completed, and construction on two new sections, "Drammen – Kobbervikdalen" and "Nykirke – Barkåker", is planned to start in 2018/19. Detail engineering of these two railway lines is in progress and others is about to start.

5.2. Tasks performed towards the Land use plan at municipal level

The work towards the Land use plan at municipal level was started already in 2015. Based on the requirements of the planning program noise consequences for several alternative corridors were calculated and described by acoustic consultants.

Typical requirements are to map the number of noise exposed home, schools and nursing homes along the new railway lines. To illustrate the noise implications of alternative corridors noise calculation are performed and presented in noise zone maps.

Due to the situation, calculations are performed both for situation with and without noise reduction measures. Based on this noise zone maps, the number of noise exposed buildings are counted and eventually noise sensitive areas that may be noise exposed in the future, are located. In this phase it is usual to compare different alternative corridor choices. Calculations are made for all the alternative corridors. The results are compared, to determine the best and worst choice due to noise exposure. Since the purpose of this phase is to choose a corridor, it is not necessary to calculate noise exposure accurate for each building and area. The noise calculations must be accurate enough to be able to make a decision about which one to recommend based on noise exposure and assumed costs for necessary noise reduction measures.

A typical result of a noise zone map is shown in figure 3.

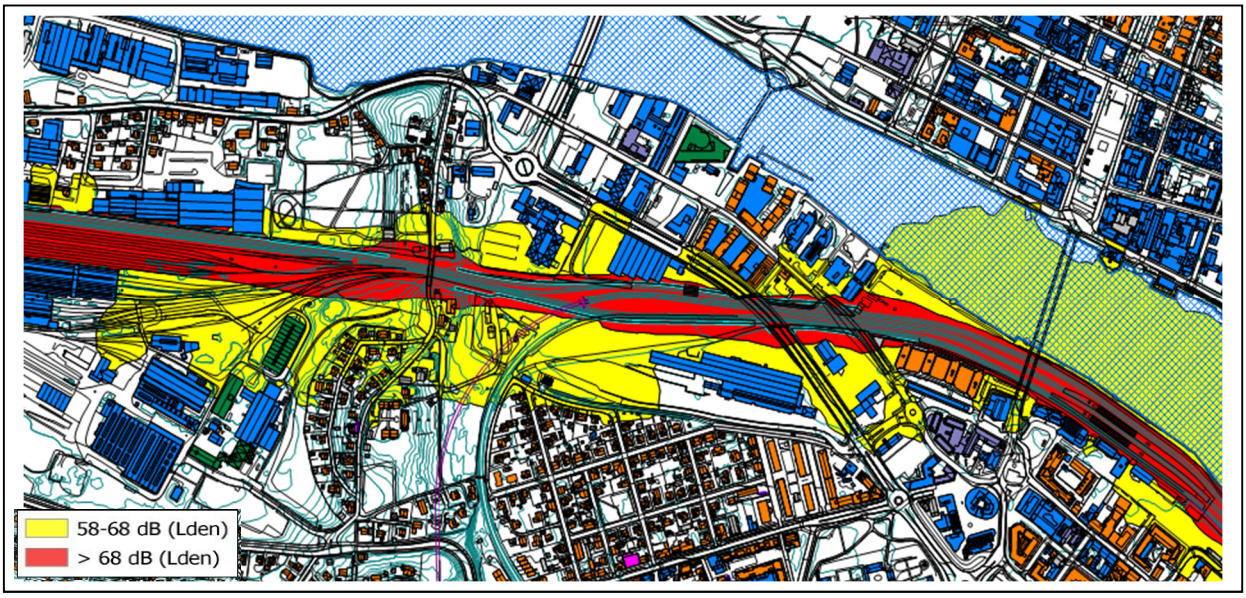

Figure 3. Noise mapping Drammen.

5.3. Tasks performed towards the Zoning plan

In the next phase one corridor is already chosen, but a more accurate location within the corridor is to be determined. With just one corridor the amount of calculations is smaller, therefor calculations will be done in greater detail. Noise zone maps will be recalculated and noise screens along the line will be optimized. In addition to noise zone maps also noise levels outside building facades are calculated. All homes, schools and nursing homes with noise levels outside the facade that exceed the set noise limit, are identified and listed in a report. All of these buildings will further on be considered for local noise reduction measures in the facade and in the local outdoor living area.

5.4. Tasks performed towards the Construction plan

When it comes to the phase of detailed engineering it is time to determine noise reduction measures for homes in more detail. It focuses on both the noise level inside the houses and at the outdoor living area. To be able to calculate the indoor noise level in a house or a flat, the entire building must be inspected to detect the floor plan and evaluate the construction of facades and windows. If indoor noise level exceeds the set noise limit, noise reduction measures must be described for facade elements.

All homes require a quiet outdoor area. It may be in the garden or on a balcony, if it is not too small. For noise exposed outdoor areas a noise screen is being described or a glazed balcony is projected if necessary.

To ensure good solutions and good adaption to existing buildings the acousticians cooperate with the architects in preparing these noise reduction measures.

6. Concluding remarks

As mentioned, there is a great amount of major railway projects planned in Norway. A lot of resources are used for noise calculations and optimization of noise reduction measures in the field of transport projects.
As acoustic consultants we contribute to ensure optimised projects and make sure that noise annoyance in the neighbourhoods near these InterCity projects will be as low as possible.

In Norway there is a guideline for handling noise in relation to land use planning, T-1442, where you find a list with recommended noise levels for different types of areas. This guideline has no legal status until it is part of a zoning plan.
All new railway infrastructure projects in Norway must be planned according to an official planning process before detailed engineering starts up within the Construction plan:

- Planning program
- Land use plan at municipal level
- Zoning plan

The Nordic prediction method for railway noise is the most common method used for noise mapping in Norway. It is rather limited when it comes to considering effects of new measures. To ensure optimised projects a group of consultants is working together with Bane NOR to make sure that noise issues are handled in the same way in different projects. In addition to discussing challenges due to the limitations of the current prediction method and necessary adaptations to data tools, interpretation of regulations is discussed. This has led to more coordinated planning of these projects, where sharing of knowledge was highly prioritized.

References

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