Abstract:

Railway vibrations: a challenge for sustainable real estate?

In the area close to the railway vibrations can be expected due to the use of the railway by trains. Especially cargo trains can cause vibrations which can affect the real estate and the well-being of the users of this real estate.

Railway vibrations are a complex issue. Passing trains – with persons or cargo – cause vibrations and these vibrations pass through the soil and can eventually reach the buildings in the neighborhood. But there are several parameters which determine if and to what extent a building can be affected by these vibrations: the type of train, the speed of the train, the rail track, the soil and the construction of the buildings in the area close to the railway.

Various organizations are involved in the governance of railway vibrations. Transport organizations are responsible for the trains. In the Netherlands ProRail is responsible for the railway. The owner of the grounds next to the railway has (in theory) some responsibility regarding the railway vibrations through his soil. And the project developer that wants to develop new buildings in the area close to the railway has some responsibility. The future users of the buildings (e.g. apartments) in general need a healthy environment to live and to work in. Not only noise but also vibrations cause annoyances which negatively affect the quality of living and working in those buildings. Severe vibrations may also cause damage to
buildings or may negatively affect the function of the building (for example a concert hall with the subway under the building).

This paper explores the governance of railway vibrations in the Netherlands. The general question that is answered in this paper is: how Dutch legislation, policy and jurisprudence (case law) deals with ‘railway vibrations’ in relation to building and real estate. Also examples are given of the governance of railway vibrations in other countries: the United States, Canada, the United Kingdom and Germany. Another, more specific question is, if and how the developer of new real estate close to the railway can be (made) responsible for taking railway vibrations into account in the design phase of the building project.

Keywords: railway vibrations, real estate, policy, legislation

Structure of this paper:

1. Introduction
2. Railway vibrations: a new environmental topic
3. Railway vibrations and real estate development: a few cases
4. Governance of railway vibrations in the Netherlands
5. Governance of railway vibrations in other countries
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1. Introduction

This paper explores the governance of railway vibrations in the Netherlands. In international literature there are much publications regarding technological aspects of railway vibrations, but publications regarding governance aspects of railway vibrations are hard to find.2

The general question that is answered in this paper is: how Dutch legislation, policy and jurisprudence (case law) deal with ‘railway vibrations’ in relation to building and real estate. Also examples are given of the governance of railway vibrations in other countries: the United States, Canada, the United Kingdom and Germany.

Another, more specific question is, if and how the developer of new real estate close to the railway can be (made) responsible for taking railway vibrations into account in the design phase of the building project.

The following actors play a role in possibilities to deal with railway vibrations.

Planning

1. Municipalities: land use plans
2. The minister of Infrastructure and the Environment who decides on track decisions (new national railways or adjustments to existing national railways)
3. Provinces decide on track decisions regarding regional railways and trams. For example: Regiotram Utrecht manages the regional tram transport system (including Uithof-line) in the province of Utrecht.

Building

4. Building of cargo trains (but they have a very long economic and technical lifespan)
5. Building of railways
6. Building of residential or business projects close to the railway

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2 References: p.m.
Management of the railways

7. In the Netherlands ProRail manages the national railways.
8. Provinces manage regional railways and trams

Use of the railways

9. Freight trains: cargo transporters
10. People trains: Dutch Railways etc.

Use of buildings in the vicinity of the railways:

11. Dwellings: people who live in the neighborhood of the railways
12. Buildings with businesses in the neighborhood of the railways

Theoretically in the phases of planning, building and management measures can be taken to prevent or reduce railway vibrations as much as possible.

The possibilities to deal with reduction or prevention of railway vibrations depend on the situation at hand and on which actor takes initiative for something. For example:

- The cargo transport organization has its own responsibility regarding for example ‘round wheels’ and the maximum load of freight train units.
- When a new track decision is drafted ProRail will have to conduct research regarding possible negative effects of railway vibrations in the environment.
- When a municipality wants to plan a new residential building block near the railway, it has to conduct research regarding the possible effects of railway vibrations on the quality of the living environment.
- When a project developer or other private actor is the initiator of a building project in the vicinity of the railways and this private actor asks the municipality to deviate from the land use plan, this private actor has to conduct research regarding the possible railway vibrations.

2. Railway vibrations: a new environmental topic

Railway vibrations are a relatively new environmental topic. The brief description of the history of this topic in this paper can start with the development of technical standards. One may assume that when engineers find it necessary to develop standards, they must have experienced problems beforehand.


Health effects of vibrations due to trains

In the Netherlands circa 845,000 residential addresses, with some 1,347,400 residents of 16 years and older, are located within 300 meter distance to a railroad track. About twenty percent of these residents experience severe annoyance from vibrations caused by trains. They complain about feelings of irritation, anger and discomfort. At night this annoyance can manifest itself in severe sleep disturbance. By far the largest part of annoyance and sleep disturbance is reported in relation to vibrations due to cargo-trains. About 528,000 people live at addresses along the railroad where vibration can be perceived, but vibrations lie below the $V_{max}$-vibrations strength of at maximum 3,2. In the Netherlands this level is used as limit value. A large part of annoyance and sleep-disturbance is found below this limit value. From a public health point of view it is relevant to also address these levels of vibration below the maximum threshold. Because it concerns a large number of residents, much health gain can be achieved here.

In order to abate these relatively low levels of vibrations not only interventions are needed which reduce the vibrations but also clear communication is necessary about factors which amplify the annoyance on top of the vibration strength. One could think of fear of damage to the home and expectations that the level of vibration will increase in the future. It is important to be aware of these feelings and to communicate in a transparent manner about future developments and potential compensation measures.

Despite the fact that the complaints exist already for years, the health effects of vibration due to trains have rarely been studied among residents. In order to gain more insight in the type and size of these effects and in whom these do occur, a questionnaire survey was held among 4927 people living within 300 meters from a railroad track in the Netherlands. This study supports further guidelines for rail traffic related vibrations, but defining the norms falls outside the scope of this report. Hereto we need more information about measures and their costs. In view of the expected increase in the number of cargo-trains at some locations it is advised to monitor the health effects of these trains.

3. Railway vibrations and real estate development: a few cases

Real estate developers strive for good investments. By making good quality buildings they try to generate the best investment. In selling brochures they often advertise about high quality living in a high quality environment. In brochures about buildings that have to be built project developers in general use nice and attractive pictures, where they show various nice environmental aspects, for example trees, water, parks etcetera in the neighborhood. Examples of project developers advertising about a project where the future users may enjoy a living free from environmental vibrations are rare.

In the municipality of Best BAN Building Company has developed the prestigious housing project ‘Park Guardians’. A consortium of the companies ‘B-Smart foundations’ and ATIS International B.V. has taken measures to prevent railway vibrations. By installing hundreds of Vibrafon pads between two foundations made of Sylodyn, the vibrations are captured both horizontally and vertically. The project located very close to a railway line is not only striking by its architecture, but also because of the special insulation for noise.

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5 The following text is the abstract of the Dutch report: Wonen langs het spoor, Gezondheidseffecten trillingen van treinen, RIVM rapport 2014-0096, I. van Kamp et al.
and vibration. As a result, the users will benefit from living next to a station and railway line without experiencing noise and vibration nuisance.\(^6\)

Actions speak louder than words. What can we learn from practice about how project developers sometimes deal with railway (and other) vibrations?

In the context of this paper we elaborate on two Dutch cases. Both deal with laboratories in existing or new buildings. Both deal with infrastructure (roads, trams) as a possible source of vibrations which can disturb the use of the buildings in the neighborhood.

**Case: vibrations in Delft**

In the municipality of Delft we find a case of a ‘vibration sensitive’ company and university which successfully and timely respond to a draft land use plan.

The land use plan ‘Technopolis Clusters and Chambers’ makes room for the future tram line 19 and a ‘turning loop’ (Dutch: keerlus).\(^7\) Close to this turning loop is an existing function and a planned (future) function which could be negatively affected by vibrations caused by the tram. It concerns the existing laboratory of VSL (formerly the Dutch Measuring Institute) en the future new Faculty of Applied Sciences of Delft University of Technology (also with a laboratory). NMI is ‘the’ independent specialist for testing, certifying and training in the fields of metrology and gaming. Both the independent measuring institute and the new faculty need protection from disturbing vibrations. Acoustic experts from Peutz have done extensive research regarding possible vibration nuisance. Acoustic reports show that the tram line and the turning loop does not lead to a degree of vibrations which compromises the operation of the two vibration sensitive functions. The location of the scheduled turning loop of the tram is chosen in such a way that the turning loop is located beyond the vibration critical distances indicated in the acoustic research. These critical distances are: from the measuring points from the new building of the faculty at 220 meters and form the measuring institute at 320 meters. The land-use map shows that at the location of the land-use objective ‘Green’ switches (Dutch: wissels) are allowed; switches are not allowed outside the specified location.

We can conclude that this case shows that is possible to keep safe distances between sources of vibrations and vibration sensitive spatial functions. When vibration problems are anticipated timely, during the preparation of the land use plan all necessary environmental research can be conducted. Based on this research a substantiated decision is possible that allows different functions because of legally (i.e.: in the land-use plan) guaranteed ‘safe distances’ between those functions.

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\(^7\) Established by the municipal council of Delft on 6 February 2014. This decision, the land-use plan and annexes (reports regarding vibrations etc.) can be consulted via: [www.ruimtelijkeplannen.nl](http://www.ruimtelijkeplannen.nl).
Case: vibrations and the design of a new building for the Dutch National Institute of Public Health and Environmental Protection (Utrecht)

Today ‘vibrations and real estate development’ are a big issue in the case of the new building for the Dutch National Institute of Public Health and Environmental Protection (RIVM) and the Medicines Evaluation Board Agency (CBG). In July 2014, on behalf of the Dutch State, the Central Government Real Estate Agency (Dutch: Rijksvastgoedbedrijf) signed a DBFMO contract with a Strukton-Hurks-Heijmans consortium. This consortium is responsible for the design, new construction, maintenance, financing and exploitation. Total estimated costs are 267 million Euro’s. About one third of the total 70,000 m² of floor space consists of laboratories. These laboratories are very sensitive to vibrations. The design of this new building has obtained the highest score regarding sustainability (‘outstanding’). On the internet we cannot find all details of this case, but it appeared that this high sustainability score did not take vibrations into account.

The Dutch National Institute of Public Health and Environmental Protection (RIVM) works with high quality laboratory devices. To be able to make reliable measurements with these devices, the new building has to meet strict requirements. In 2015 it became clear that the original design didn’t meet with vibration requirements for laboratories. The search for a solution took a lot of effort. In this new building situation there are various sources of vibrations. Traffic in the streets surrounding the new building, persons who walk in the building and the future tram/metro that will ride along the building may cause vibrations. Vibrations of and in high rise buildings can also be caused by wind turbulence. It took quite a long time doing research on the influence of vibration sources on the building. An external engineering company has built a calculation model. This model is very complex and calculations took much time. Calculations results show that the vibration problem is caused by (future) traffic in the neighborhood of the building, for example cars and the future tram/metro (Dutch: Uithoflijn).

At the end of 2016 the consortium has inserted various anti-vibration measures into the design. The following measures are mentioned on public websites: the use of larger and longer foundation piles; a heavier foundation; specific ‘air holes’ (Dutch: luchtspouwen) in the soil around the building; and moving the tower and the wing with specific laboratories 20 meters southwards from the tram way.

On the 16th of January 2017 the Central Government Real Estate Agency issued a starting certificate. At that time the start of the building activities was expected to be in Spring 2017. This certificate confirmed that the consortium had sufficiently elaborated the design and that the building can be built in accordance with the set requirement.

A recent publication in ‘General Daily News’ (Dutch: Algemeen Dagblad) shows that there is clarity about the technical measures that have to be taken to prevent vibrations. However, at

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8 This case description is derived from information on the following websites, consulted on June 27, 2017:


[http://www.ad.nl/utrecht/gesteggel-over-trillingen-vertraagt-nieuwbouw-rivm-op-de-uithof~a0cc609f/](http://www.ad.nl/utrecht/gesteggel-over-trillingen-vertraagt-nieuwbouw-rivm-op-de-uithof~a0cc609f/)

Last mentioned website contains a publication with the title: Discussion about vibrations delay new RIVM building at De Uithof (Dutch: Gesteggel over trillingen vertraagt nieuwbouw RIVM op De Uithof), published 27 June 2017.
the moment the Central Government Real Estate Agency and the building consortium are still discussing the financial consequences of the vibrations. The ongoing discussion is about the costs of the anti-vibration measures and how these costs have to be divided between the actors involved.

4. Governance of railway vibrations in the Netherlands

[This section will be elaborated at a later date.]

In the Netherlands railway vibrations as such are not legally regulated. There is no legal standard or limit value that precisely limits the amount of allowed vibration nuisance. However, there are some general legal requirements which imply that in the preparation of spatial decisions (e.g. land-use plans) research regarding (railway) vibrations has to be conducted.

No specific legal requirements, but we do have a Policy Rule regarding Railway Vibrations Nuisance (Dutch: Beleidsregel trillinghinder spoor). This Policy Rule is applied in Track Decision procedures regarding a new railway track or an adjustment of an existing railway track.

Railway companies (e.g. ProRail in the Netherlands), municipalities and developer/builders of new buildings in the vicinity of railway all have their own responsibility in dealing with the prevention of possible nuisance and damage caused by railway vibrations.

In preparing spatial decisions, for example regarding a new land use plan, municipalities are legally obliged in the Netherlands to meet the criterion of good spatial planning (see for example article 3.1, section 1, of the Spatial Planning Act).

Project developers have at least a social (non-legal) responsibility towards the future users of the buildings the develop. When project developers raise expectations regarding a healthy living environment, users may expect that they deal with possible environmental problems that negatively affect the quality of living. Clients and contractors can make specific arrangements regarding anti-vibration measures which they lay down in the building contract.9

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5. Governance of railway vibrations in other countries

[This section will be elaborated at a later date.]

Example: Concert hall in Manchester

http://www.acoustics.salford.ac.uk/acoustics_info/concert_hall_acoustics/?content=unwanted_sound

http://www.acoustics.salford.ac.uk/acoustics_info/concert_hall_acoustics/?content=index

“The risk of disturbance due to groundborne railway vibration was identified at the outset of the concert hall design in 1989 and vibration isolation was incorporated in the building to mitigate the problem.”

6. Conclusions

[This section will be elaborated at a later date.]