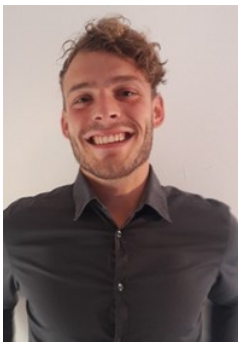
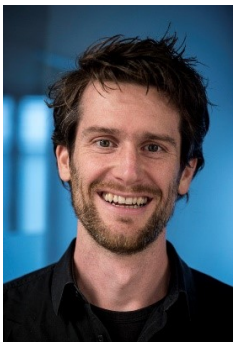
FUTURE ASSET MANAGEMENT
'Role of Road Freight Traffic Load Information'



RICK C. SMITS
Advisor,
Rijkswaterstaat,
Ministery of
Infrastructure
and Water
Management,
Netherlands



JOEP PAULISSEN
Consultant
TNO
Netherlands

Abstract

As a national road authority (NRA) the role has shifted in recent decades from a road network developer to an asset manager. Developments in ageing infrastructure, growing road freight traffic (RFT), in volumes and weights, demand higher quality information about the state of the infrastructure and the usage of our infrastructure by RFT. The Dutch NRA 'Rijkswaterstaat' is starting new initiatives for collecting data of higher quality to improve their asset management strategies. A lot of these initiatives have just been started, this paper gives an overview of the latest data related projects regarding RFT load information.

Keywords:

1. Introduction

The national road authority in the Netherlands (Rijkswaterstaat) is maintaining roughly 3 thousand kilometer of motorways. This may not seem much, however Rijkswaterstaat also maintains over one thousand bridges and tunnels. Most of these structures have been built between 1960 and 1980 and are up for replacement or renovation in the coming years. Therefore the '*Replacement and Renovation Program*' (RRP) has been started up in which a large number of the older structures will be renovated or replaced in the coming decade.

New infrastructure comes with huge amounts of money and the reasoning for a specific type or quality has to be done carefully, because it assumed to be operational for a long period of time. At the same time a lot of information that a road authority needs to make careful decisions, in terms of quantitative data, is unavailable. A quote our prime minister used during the corona pandemic is also applicable here: '100% of the choices need to be made with only 50% of knowledge'. It is therefore necessary to gather all available data to make the best choices possible.

In the Netherlands, the main role of the road authority has shifted in recent decades from a road network developer to the role of an asset manager. The road network has been built in the previous decades and now shows need for maintenance instead of studies for new infrastructural connections. This paper will discuss potential best practices that can be performed with the data that is being gathered or combined at this moment in the Netherlands. It will also discuss policy choices that might be made with it for futureproof asset management.

2. Background and context

Asset management is about maintaining current assets and making strategic choices for the future. As mentioned in the introduction a lot of structures are built multiple decades ago and are up for replacement or renovation. Rijkswaterstaat performs a study every four years called: 'State of the Infrastructure' in which the state of assets are presented [1] . The diagram below shows the amount of concrete structures and the year of construction.

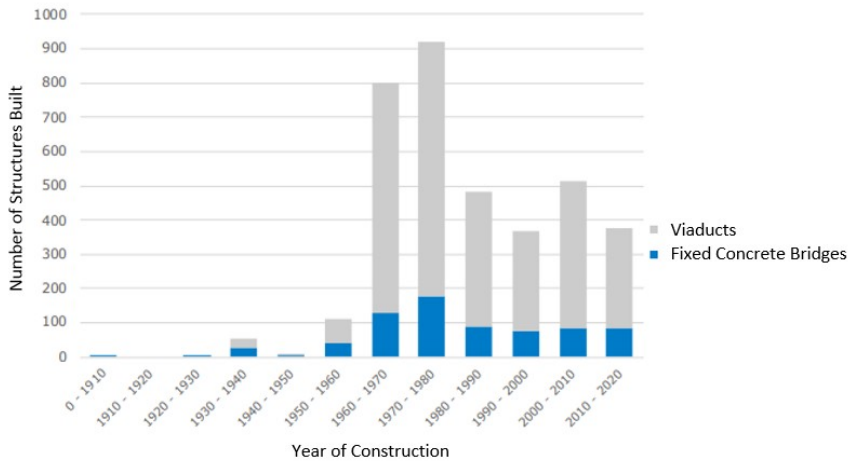


Figure 1 Number of concrete structures built per decade, Rijkswaterstaat (2020).

The 'Replacement and Renovation Program' is started for a systematic approach in replacing and renovating structures. One of the main limitations of this program is the lack of knowledge about vehicle innovations and other logistic developments that can take place in the (near) future. At this very moment many technical innovations in the freight transport sector are happening. Due to climate goals, several European countries are considering allowing High Capacity Vehicles such as EMS1 and EMS2, for example Sweden and Spain [2].

Figure 2 EMS2, Duo-Trailer or Super EcoCombi

In 2018 the relation between deterioration and road usage by road freight transport was investigated [3]. Overloading has a clear share in deterioration and with new vehicle configurations like the EMS2, because of its higher maximum weight, this might be worsened. The figure from the ITF (2018) report is a rough estimate on the effects on the deterioration of infrastructure. The exact quantitative relation between the usage of road infrastructure and the damage or increased wear is unknown.

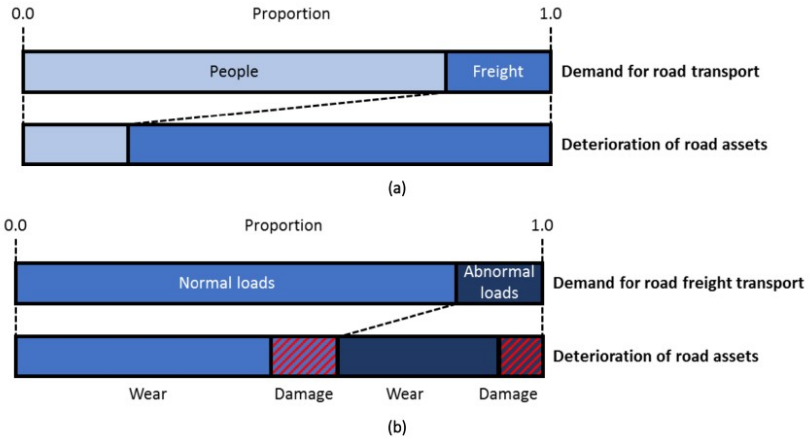


Figure 3 Estimated effect on infrastructure due to freight transport (ITF, 2018)

Last year the Dutch research organization 'Ecorys' did a prognosis study on the change of the Dutch heavy duty vehicle fleet due to technical innovations and logistic developments. The results were clear that an increase in technical innovations and logistic developments lead to a more efficient use of heavy duty vehicles and the use of longer and heavier vehicles [4]. This might not be surprising, but interesting is that both the aspects are at this moment encouraged by policy makers to achieve climate goals. These vehicles have higher maximum weights which have a (possible) negative effect on existing infrastructure, but also on infrastructure that will be built within the RRP.

There seems to be a trade-off between climate related solutions and the physical infrastructure in the (inter)national road networks by a more efficient use of heavy duty vehicles and allowing bigger vehicles to reduce emissions. The main uncertainty is: To what extend is the changing usage of the road network by road freight transport causing more damage to the physical infrastructure than expected? And how can available data be used to gain insight on the matter?

3. Currently used data on the usage of the road network

To measure the effects of the usage on the infrastructure information is needed on the state of the infrastructure, but also on the usage by road freight traffic. Currently three sources of data on the usage of road infrastructure by heavy duty vehicles are used in The Netherlands to gain insight:

- Induction loop data *(for counting the intensities of vehicle types)*
- Data from surveys among transport companies *(as input for freight models)*
- Weight in Motion (WIM) data *(as input for traffic load models on structures)*

The induction loops give a good insight in truck intensities, but lack in detail. They don't provide detailed categorization of trucks, gross vehicle weights (GVW) and axle loads. The data surveys are performed every year to gain knowledge on the usage of the network but have a low response rate. Together these data sources are not sufficient for determining the physical loads on the infrastructure. The WIM-systems should give more detailed insight on

the usage, but for technical and organizational reasons, there were difficulties to keep these systems operational [5]. Renewed effort is being made to fully repair the WIM systems and extra WIM-points will be placed. However there is need for a more reliable data source, because these systems have proven themselves to be fragile.

4. Upcoming additional data sources

In the near future three new sources of data on the usage of the infrastructure by road freight transport will become available:

- More detail in logistic data
- Truck charge data
- Intelligent Access data

Pilot Project 'Container movements in the logistic chain'

In 2020 the pilot 'Container movements in the logistic chain' started. In the pilot a test was done to what extend data from (road and rail) transporters, shippers, terminals and ICT suppliers could be gathered by our national bureau for statistics (CBS). The main reason for this test was the need for more realistic predictive models. At this moment the models are based on induction loops with only three different types of vehicles based on lengths together with a questionnaire for road transport companies to gather a rough estimation of the types of goods that are transported. The other motivation is the political preference for more transport over water. That initiative is translated into multiple 'Modal Shift' projects. There is only need for more detailed information on routes, type of goods, modal choice and lead times. For the road authority, that also maintains the main waterways, it is also important to know what is transported. There might be types of goods that can be transported more efficiently via water or rail and reduce the pressure on the road network. Also the weights of the containers in combination with the vehicles can be gathered from the data, which generates higher quality data in terms of the loads on the network. The pilot showed that the type of data or information is possible to gain with a few points of attention [6]:

- Data collection should be done under strict authorization terms
- Portals need to be developed (no system is the same)
- What is in it for the data supplier?

In the project iShare is used as a standard for sharing data. The terminal, shipper, carrier or forwarder give explicit permission for the transfer of data in an authorization register, and only then may data actually be transferred. These iShare permissions ensure that the data sharing process proceeds smoothly and in a controlled manner for all parties involved. The Portbase authorization register complies with the iShare standards. In the interests of all stakeholders, CBS, Rijkswaterstaat and Portbase are striving to achieve an effective application of the iShare system.

Different logistic companies use different software packages that are often modified to their needs. This means that software developers need to build data portals for the different software packages and a connector from the logistic organization towards the portal. The most difficult question to answer is: 'What is in it for the data supplier'. A lot of bigger

organizations have joint the project out of a social sense of responsibility. For smaller companies, for example road transporters, it becomes more difficult since there is no capacity in their organization to contribute to the project. For now the labor needs to be compensated, but in the future this might shift to other advantages.

Truck Charge

Already in 2017 the Dutch government has started looking into the possibilities of 'Truck Charge'. The initiative is a potential project in which data on usage can be found to build a foundation for future policy measures. Vehicles are registered when entering the motorway, which gives detailed information on the routes that transporters use in the Netherlands. The main supporting argument for the introduction of the truck charge is that the revenues from this tax system will be used to improve the logistic chain. Therefore the quality of the data collection needs to be high and therefore also useful for a NRA. However this policy proposal will not be introduced earlier than 2024, therefore this data cannot be used in the coming years.

Intelligent Access

Another interesting initiative is the 'Intelligent Access (IA) Project' from Rijkswaterstaat. Several forms of access policies for transport can already be seen in the Netherlands and other countries. The best known are the regional or local environmental zones, which are being tightened up to Low and Zero Emissions Zones. In addition, there are systems to collect tolls that also regulate access to roads. Another example, that is particularly interesting regarding RRP, are restrictive conditions for freight traffic with specific structures along the motorway.

Rijkswaterstaat is therefore looking into possibilities for IA according to the Australian model. At this moment heavy duty vehicles can ask for a permit to use a specific part of the road network, but there is no capacity to control all those movements and maximum weights. With knowledge on overloading and the introduction of the EMS2 this seemed a logical moment to gain more control over the usage of the road along with data on the weight and axle loads of these heavy duty vehicles. With this intelligent control on the usage of our network by heavy vehicles the national road authority can protect its assets. In 2021 the project plan will be finished and the first steps towards IT service providers has been set.

Object monitoring and Road / ANPR camera's

Besides the three data sources on the usage there are two other potentially interesting additional data sources:

- Object monitoring (Bridge-WiM)
- Road / ANPR camera's

The RRP requires accurate structural assessments of existing objects like bridges. To feed and/or verify such assessments more and more object monitoring takes place in the Netherlands. For example by means of strain measurements to validate/calibrate structural analysis models and/or to obtain bridge specific load effects. These data also contains

(indirect) information about the traffic loads causing the measured load effects. TNO is developing software to deduce this information from the measurements. Two application scenarios are investigated (i) an add-on scenario in which the aim is to obtain as much as possible information from given (non-ideal) measurement data for other purposes and (ii) a dedicated scenario in which the sensor layout is optimized to obtain traffic load information. The first will be more cost-effective, the latter will be more will provide more complete and accurate information and is also known as Bridge-WiM.

Another potentially interesting data source is video footage. There are many camera's besides the road, e.g. for traffic flow monitoring and license plate registration (ANPR). The footage contains information about the passing trucks. In combination with digital image processing techniques and/or linking to license plate information registers (as for example available at Dutch RDW) this is an interesting source for detailed information about road usage by freight traffic. Of course legal and privacy aspects are an important point of attention. However, for application for traffic loads no personal or organizational information is needed. So, it might be possible to tackle these issues with appropriate anonymization.

5. Data usage and policy development based on the current 'data one has got'

In the previous sections potential new data sources have been shown, but these data sets are at this moments still unavailable. An end point in the data interpretation could be the quantitative relationship between the usage and the deterioration of the infrastructure.

Unfortunately it will probably still be difficult to find the quantitative effect of road freight transport on the infrastructure after the data gathering that is proposed, but regarding the RRP there is need for information on the expected load on the network. Therefore the following studies / developments are being performed:

- Study on overloading
- Models for quantitative scenario analysis
- Development of a Load Map
- Predictive Twins of Structures
- Dashboard Constructive Safety

Study on Overloading

Overloading has a big influence on the costs for maintaining infrastructure and the depreciation period of structures. Therefore the first step that will be taken is to redo a study on overloading. This study has been performed back in 2014 with the conclusion that the percentage of overloaded vehicles was high with EMS1 vehicles and mobile cranes. With the information the road authority might be able to see the developments in overloading and develop a more accurate fining system in order to protect its assets. Also the structures could be built taking into account larger volumes of traffic and higher maximum loads. This study will be performed by the end of 2021.

Models for quantitative scenario analysis

As part of a European program Ursa Major neo TNO conducts research into the expected quantitative impact of innovative transport concepts (Truck Platooning and Super EcoCombi) on various aspects of infrastructure and its usage. One of these aspects is the impact of new transport concepts on the traffic loads to be taken into account for structural assessment of existing structures and design of new structures. Models are developed that enable quantitative probabilistic scenario analysis for a representative sets of structures.

Load Map

The Load Map is a development towards GIS-application service that stores, connects, enriches and disseminates data and insights about the usage of infrastructure networks by freight traffic. One of the primary goals is to obtain consistent and accurate information about asset/location specific traffic loads from all the data sources that are available. This is to gain insight in diversification of traffic loads for the RRP. Models are developed that can be fed with a variety of data sources containing information about usage by freight traffic. Other envisaged functionalities are status indication of monitoring systems, (automatic) trend monitoring and prediction of future scenario's. The value of this development has multiple angles, namely organizational (availability, quality, efficiency), technical (accurate and insightful information) and it connects disciplines (bridges, roads, mobility and policy). TNO initiated the development in one of her knowledge programs. The development is now at the stage to interact and connect with potential partners. This will continue in 2022.

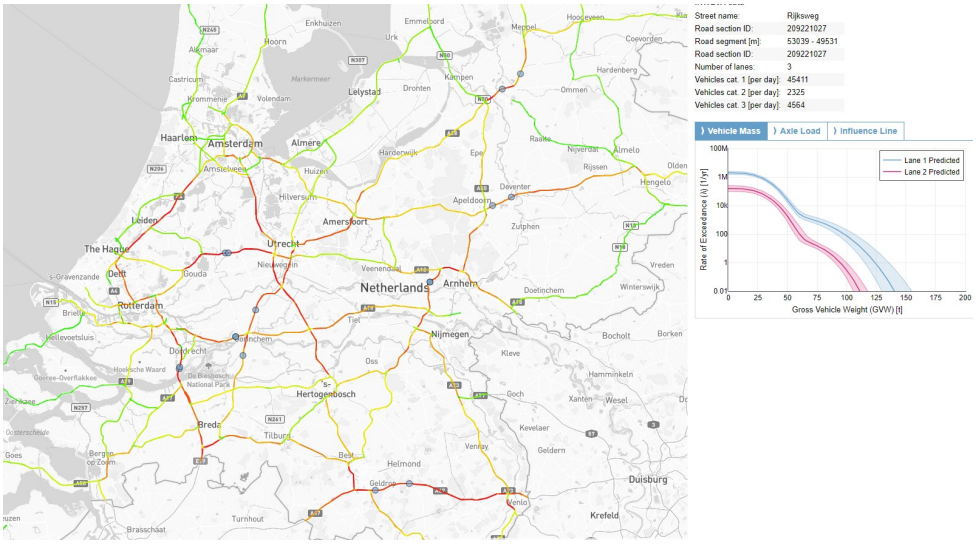


Figure 4 Visualisation of the Load Map

Predictive Twins of Structures

This development aims at the ability to create digital copies of structures that are fed with actual data and have predictive capability towards KPI's structural safety and service life. This supports a shift from traditional assumption and code based structural assessments,

towards more data supported and digitalized structural assessments. It is envisaged that this can result in better justified prioritization, planning and scoping of maintenance, repair and renovations, which is important for the Rijskwaterstaats' RRP. Other asset-managers have similar challenges. One of the key challenges for developing Predictive Twins is the ability to translate actual observations (data) to KPI's for structural safety and service life that ensure (very) low probabilities of failure. This is done by models capturing the key aspects of structural assessments being loads, structural behaviour, and resistance/degradation rate of structures. Actual and future usage of structures by freight traffic is an important aspect. From 2021 onwards, Rijkswatertstaat and TNO are going to collaborate in this development. Part of this is developing a Field-Lab in which various partners can participate.

Dashboard Structural Safety

Since the foundation of Rijkswaterstaat inspection reports have been made for structures based on the service level agreements in which all parts of the structures are covered. These reports are mostly textual and therefore difficult to administrate into a digital form. The new Dahsboard Structural Safety is aiming to digitalize the observations with more accuracy. The project involves determining the structural safety of the concrete bridges and viaducts from the RWS area. The basis for determining the structural safety is the current Eurocode. Where possible, in consultation with TNO and TU Delft, the expectation was examined where and for which construction types refinements to these Eurocodes are possible, feasible, efficient and realistic. The aim of these refinements is to determine the structural safety more accurately, so that unnecessary rejection (for which works of art have to be strengthened or replaced) is minimized.

Program Core Network Logistics

The program 'Core Network Logistics' is the last initiative within the organization of Rijkswaterstaat worth mentioning. The program is started by looking at the developments within the logistic sector that is still growing by looking at the prognoses. Additionally a lot of measures will need to be taken to reduce the amount of CO_2 and achieve other sustainability goals. This will probably, by looking at the research by Ecorys [4], increase the maximum vehicle weights by allowing bigger vehicles or with the usage of battery electric trucks.

This program is aiming for a differentiation within the main road network for freight traffic, where routes can get higher priority than other regarding freight traffic. The heavier vehicles, needed for climate goals, can be used on these corridors, while remaining refused on the rest of the network. These corridors might come with higher standards for pavements and structures to reduce the wear and damage. The program has high interest in the outcomes of the previous mentioned research initiatives and can therefore function as a knowledge platform on freight traffic and the impact on the infrastructure. The program has been approved by the ministry, but is still in development.

6. Conclusion

The data that is available at this moment cannot satisfy an asset manager in the need for information about the impact of freight traffic usage on infrastructure. The level of detail is

not sufficient looking at the current induction loops, state of WIM-systems and surveys among transport companies [5]. Therefore the coming years multiple new approaches will be examined. The purpose of this paper is to give an overview of the initiatives in the Netherlands to give other NRA's the opportunity to gain knowledge on other types of data that is gathered to improve their asset management or strategy regarding growing road freight traffic.

The quantitative relation between deterioration and usage might not be found, because the application for data on infrastructure is still in development, However the data available can be used for strategic policies to extend the lifetime of structures, reduce the costs for maintenance or make strategical choices regarding replacement or renovation. The practical solutions might be found in the differentiation of rebuild quality, but the possibilities depend on the outcomes of the researches.

It is clear as a reader of this paper that the level of academic content is low, but this document has higher ambitions. In the coming years a lot of contradictive developments are predicted and for an asset manager there is need for more specific data on the usage of the infrastructure by road freight transport to make the best strategic decisions regarding asset management. With this paper a clear overview is given of the approaches that were chosen or are under development in the Netherlands to share with other NRA's.

7. References

[1] Rijkswaterstaat, "Staat van de Infra RWS," Rijkswaterstaaat, Utrecht, 2020.

[2] B. C. I. a. C. Delft, Super EcoCombi; Verkenning van kansen en verwachte effecten, Delft: Topsector Logistiek, 2020.

[3] ITF, "Policies to Extend the Life of Road Assets," *ITF Research Reports, OECD Publising, Paris,* 2018.

[4] Ecorys, "Scenariostudie toekomstig gebruik weginfrastructuur door vrachtverkeer," 2020.

[5] A. Vervuurt, L. Aarts and H. van Meerveld, "FUTURE OUTLOOK FOR TRAFFIC WEIGHT MEASUREMENTS IN THE NETHERLANDS," Heavy Vehicle Transport & Technology 16, 2021.

[6] M. Jacobs, "Focus on container traffic, from seagoing vessel to HGV," *Central Bureau for Statistics and Rijkswaterstaat,* 2020.

[7] A. Del Grosso, D. Inaudi and L. Pardi, "Overview of european activities in the health monitoring of bridges," *First International conference on Bridge Maintenance, Safety and Management, IABMAS,* vol. 2, 2002.

[8] J. Velde van der, L. Klatter and J. Bakker, "A holistic approach to asset management in The Netherlands," *Structure and Infrastructure Engineering,* vol. 9 (4), pp. 340-348, 2013.