Future roads and mobility

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Asfalt Impulse program - A Dutch program to stimulate asphalt improvements

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Abstract

If technicians and asphalt research employees talk about their business, all are eager for change and aiming for more sustainability. Most times people among themselves look to the other party to get progressions in our field of business. And budget for research is always hard to achieve, let alone the need for test-sections to experiment in the field. In The Netherlands this all plays as well; The contractor has wishes for the road-authorities, road-authorities ask new development options at the consultancy agencies, asphalt-plants need options for innovations within projects and so on. Out of this starting point, and the believe that our whole business can do a whole lot better if we get the right chances, a complete new initiative is born; an impulse to the asphalt branch as a whole. In 2018 a big project is started, the Asphalt-Impulse, with a combined budget out of the complete range of the sector. This project started in 2018 and will be continued for the next 5 years. Within the Asphalt-Impulse program all stakeholders work together with a common following aim: ”Doubling the lifetime of asphalt pavements, halving the scatter in lifetime, halving the CO2- footprint at same or lower cost”. All players in the market are asked for suggestions to get an impulse on asphalt. Six themes were chosen to gather the these wide range of ideas. The best projects are selected and these 8 projects will start: Demonstrable sustainable asphalt mixes, Better asphalt mixes in contracts, Asphalt quality counter, Grip on bitumen, Functional acceptance, Hightech = Lowcost, Quality assurance and Lifespan prediction model for asphalt mixes. In this paper more detailed will be looked into the drive to start this project and will explain of the eight selected projects, what this beholds and was is aimed for.

This paper was first published in 2020 in version 1.0 of the proceedings of the 7th E&E Congress. This second edition (version 1.1.) of the proceedings is published in June 2021. The content of this paper has not changed, but the author(s) may have provided additional information in the form of an annex.

1. INTRODUCTION

The Netherlands is very densely populated, resulting in a high average traffic intensity, comparable to cities like Beijing. Congestion rates are high, while traffic intensity keeps rising.
The economy in Europe is growing and the Netherlands has its part in this, with the biggest port of Europe, Rotterdam, and the international airport of Schiphol Amsterdam as important contributors.

At the same time the availability of natural resources is declining. Oil companies try to obtain as much fuel as they can, from each barrel of crude oil. Consequently, the amount and quality of bitumen that is available is changing. As a result there is currently no bitumen being produced in The Netherlands. Preferred aggregates in asphalt concrete of The Netherlands are high-performance types as Bestone, and Grauwacke. As there are no mountains in the estuary of the Rhine and the Scheldt in the Netherlands, all these materials are imported.

To complete the above challenges' our government strongly supports the Paris Agreement for climate change. In the construction and maintenance of our roads the effects on the environment are of major importance. Contracts in 2019 demand the contractor to deliver asphalt with a maximum MKI (acronym for environment cost indicator).

The best way to meet all of the challenges mentioned above, is by prolonging the lifetime of Dutch asphalt. We believe this can be done by optimising quality in the production and execution processes, having maintenance options available that give rise to extra lifetime during usage of the road and reusing all constituents of the used asphalt pavements in the new pavement layers in high fractions while minimizing downcycling by using recycling material from surface layers in new surface layers. A research program is started in Netherlands to formulate the strategies to achieve these goals and come up with tools on how to value quality in the procurement process.be able to come up with the improvements needed to realize this. In this programme eight projects are running in parallel. The topics of the projects have been selected by the whole asphalt sector as being relevant to achieve a longer service life with a lower carbon footprint.

In this paper a detailed overview of the reasons to start this programme is presented in chapter 2. All eight selected projects will be explained in the chapters 3 through 11, focussing on their contents and aim and if present achievements so far.

2. THE START OF THE ASPHALT-IMPULSE PROGRAM

In 2016 a program was started in the asphalt sector to investigate how to meet the climate challenges and to stimulate innovation. The program has started with a session to collect ideas from the entire asphalt community. Contractors, engineering companies, government, laboratory facilities, road authorities, knowledge institutes, universities, specialists on circular economy, material suppliers, the bitumen industry and others were welcome to participate. 90 participants took part in a brainstorm session. Everybody was encouraged to come up with ideas for designing and realising better roads and better asphalt. In total, 37 plans were brought in. Luckily a few of them focussed on similar ideas, and some plans could easily be combined with other plans. A second brainstorm was organised and this time 120 people participated. After discussions and exploration of the options, 25 ideas were selected, of which 12 plans were given priority ‘high’ or ‘middle’.

To generate ideas was not the biggest challenge. Until then, all participants had delivered their support 'in-kind' without a pay-check, but the actual research obviously will take serious time, materials and equipment. A first estimate amounted to k€ 1195 for year one, needed to be able to start all the plans. All participants were encouraged to chip in serious money. In the onset most parties were very reluctant, but it ameliorated when the national road authority stated that they would contribute k€ 500 per year for this 5-year project. The provinces (12 combined) promised a contribution of k€ 100-150 per year. It turned out to be harder to get individual private companies such as road-builders, asphalt-plants and engineering companies involved. But in the end, the branch organisation of asphalt contractors chipped in k€ 200. Next to the financial donations, substantial in-kind donations were given. From this starting point, more parties joined in.

It was decided that all donating parties would be part of the steering committee. This was vice versa: if you would like to participate in a project group or in the steering committee, financial participation was required as well.

Having a considerable amount of financial and in-kind contributions available, the steering committee decided that the eight projects that were valued most interesting in the brainstorm session, could actually start now. It concerns the following eight projects:

1. Ascertainably sustainable asphalt-mixes
2. Better asphalt mixes in contracts
3. Asphalt quality counter
4. Grip on bitumen
5. Functional acceptance
6. High tech = Low cost
7. Quality assurance
8. Lifespan prediction model for asphalt-mixes.

3. VERIFIABLE SUSTAINEBLE ASPHALT-MIXES

Governmental parties as well as asphalt contractors all want to use asphalt that is highly sustainable, still very durable and possibly even completely circular. As all government parties share this high ambition, therefore they recently started with contract formats that aim at realizing a asphalt with a lower environmental impact while sustaining the performance. In the tender process for these contracts, a level playing field is aimed for, to try an challenge the market to come up with innovative solutions while mitigating risks.. Implementation of this type of tendering process needs to be done in a responsible manner: good products need to be distinguished from badly performing products. Claims of an contractor should be attained in the field.

Therefore in the Asphalt-Impulse program one project group made a start in developing an measuring system that is to be widely accepted in the asphalt industry. For all asphalt mixes an MKI will be determined (a Dutch acronym for Environmental Cost Indicator). The impact of all constituents of the asphalt-mix are taken into account. This includes the excavation, transport, processing, and stockpile at the plant all together. In total eleven factors are determined in the MKI. The calculating system is in line with EN 15804.

The MKI of seventeen most widely use standard asphalt mixes have been calculated, in order to obtain a reference starting point for contracts. New innovative mixes should score better results than these standard mixes. This is not easily attained, because nowadays all asphalt-plants already have about 50% to 60% RAP (Reclaimed Asphalt Pavement) as a standard mix. This high amount of RAP could be achieved because all asphalt-plants have parallel-drum systems in place. For new mixes to score better MKI's, the innovations needs to be taken to a next level.

Therefore new asphalt mixes will be designed, new production processes will be tested and new types of asphalt plants will probably come into play. This makes it hard for the project group 'ascertainably sustainable asphalt-mixes' to make the MKI system robust. The measuring system should be as uniform as possible, and all calculated values must be validated. Therefore new and more concise Product Category Rules will be drafted, that are also able to address the specific recycling tradition in asphalt.
The project group will need to look into all kinds of oil based products and bioproducts for binders, additives, and rejuvenators. A range of 'live-prolonging ' products is available in the market, but how to validate this still needs to be decided. By-products from other industries are sometimes claimed to be a plus for sustainability. But it will have to be validated how circularity of these products should be calculated.

While this project group is gathering its information and has started to develop and update the system, development of similar calculating systems is taking place elsewhere in Europe as well as worldwide. In the ideal situation the project group wants to anticipate on these developments and wants to assure that MKI-calculations in the future will still be valid. Probably, a yearly update will be necessary, in order to comprise all new developments in the calculating-tool.

In the end, this still is a calculation on paper at the start of a project. The project group is contemplating how to verify the actual MKI of asphalt layers after mix production and paving.

A goal of the Asphalt-Impulse is that in future all contracts will have incorporated the MKI-parameters in their contracts. All asphalt plants and contractors will obtain higher revenues as soon as they produce the best and most eco-friendly asphalt.

4. BETTER ASPHALT MIXES IN CONTRACTS

One project group is looking into contract specifications which encourage contractors to develop better asphalt mixes. The main goal is to stimulate contractors to fulfil the goals of the asphalt-impulse; 'Doubling the lifetime of asphalt pavements, halving the scatter in lifetime, halving the CO_2 footprint at same or lower cost'.

Many times a contractor is being addressed when the quality of the product is not meeting the requirements. Unfortunately, if the product is of outstanding quality, he probably will never hear about this. But it is of high value for the client when the product is of high quality. It might even be worth extra money as soon as the contractor can make the product better than the standard requirements.

Would it be possible to have specific types of contracts where as soon as an extra value is obtained, the contractor will get payed for the extra effort? And maybe it is not always needed to pay in euros, but instead a reward in extra publicity might be fair. Sometimes it might be possible to obtain past-performance points in a next tender.

In all, the project group wants to explore if there are ways to stimulate the contractor to deliver outstanding quality.

Some agencies are reluctant to use such a system in their contracts. It is very important to discover the reasons for this hesitation to use it. For the project group it is important that contract models are provided that eliminate the uncertainties in such a way that basically everybody can use the model.

If this project group succeeds in its goals we will get contracts, where;

- Processes are well organized, with the main focus being to work in a "first-time-right" principle.
- All preparations before starting the project have focus on time management (low on hindrance), costs (value for money) and quality (high on performance).
- The crew on the job-site is completely in control. An (unexpected) inspection on site turns out to be just a visit because no flaws can be found.
- Directly after the paving process, the laboratory of the contractor will run tests. Ideally all these tests turn out to be within the requirements.
- If, for instance, an abrupt weather change occurs, the contractor will do extra tests on the location that was affected. If the tests don't meet the requirements he will make suggestions how to overcome this set back.

To give an extra insurance, it might be possible that the contractor will run verification tests at an independent laboratory. In this way proof can be given that the results the contractor reported are trustworthy.

All these extra steps a contractor can do, should have value for the road owner. The project group has the task to make contract specifications that facilitate and stimulate the contractor to deliver a high quality product.

5. ASPHALT QUALITY COUNTER

Contractors, asphalt plants, engineering & research facilities, they all come up with new products every year. Having goals to reduce CO_2 and to reuse and recycle materials if possible, stimulate the development of new asphalt mixes. Some products are claimed to use less raw materials, some asphalt mixes are claimed to be produced at low temperature with quality at an comparable level. Sometimes a claim for a longer life-times of the asphalt-layer is made.

Within the Asphalt-Impulse there is a need to have an independent and professional performance review of these claims. The customer (road authority) needs to know if all claims that are made are legitimate. In a tender, all contractors need to have a level playing field to win the contract. May the best one win; but this should be the actual best one and not the one that has a mixture of gross exaggeration and overstatement of the properties of this asphalt mix.

With the start of the Asphalt-Impulse the Asphalt quality counter started as well. It consists of a team of experts. All of them are specialists in the field of asphalt layers, mixes and materials. This is combined with specialist in the field of environment impact and chemical knowledge. Some used to work at an asphalt plant or with a contractor. Other specialists are project at an independent engineering company, independent laboratory or at an university. As soon as an request is being done at the Asphalt quality counter, a team of three experts is being formed. At every request a match is made between the specific type of product and the special knowledge that is needed to review the claims made.

Every innovative producer can make a request. But it is not only products; innovative production- or paving processes can be evaluated as well.

This Asphalt quality counter will help to increase the capacity to innovate in the road construction sector as a whole. And it will give insurance to the costumer that the technical innovation is validated.

6. GRIP ON BITUMEN

Innovations in the production of fuels for transport have their impact on bitumen. There are many new processes at the refinery where crude oil is transformed and refined into more useful product, such as gasoline, diesel fuel, kerosene and other fuel oils. The bitumen is obtained as the "heavy" (i.e., difficult to distil) fraction. New ways to upgrade the distillation process result in new product flows. The end product bitumen is changing due to this.

In Europe there are several normative guidelines available for asphalt concrete as well as bitumen. These specifications were made based on the 'old' bitumen products. Asphalt plants and contractors have seen that the bitumen products have changed and as a result the asphalt mixes are changing.

In The Netherlands functional specifications are used for the base and binder layers in all contracts. Furthermore, many contracts have functional specifications for road design as well. Within the design manuals, all known aspects that influence the construction are used in models. These models originate from known asphalt mixes, mostly based on straight run penetration bitumen . On a different level, questions arise if all the knowledge of bitumen and asphalt mixes is still applicable for the new products that are used in roads nowadays. There is a need to get a better 'grip' on bitumen.

A wide range of European standards is available for bitumen and asphalt concrete. For the CE marking a number of characteristic features have been defined. It is necessary to gain insight into the distribution of these properties and the influence of the variation on the properties on the end product. This applies to all phases of the end product asphalt concrete: production, processing and end use. At the start of this project it is unclear whether the functional behaviour of the bitumen is sufficiently recorded. Along with this there is no clear picture of the bitumen characteristics which determine the quality of bitumen.

Within this project, bitumen quality is considered to be the ability of bitumen to be applied in one asphalt-mixture in a road construction in a certain situation, to offer long-term resistance to the loads (and damage mechanisms) so that the requested functionality (e.g. flatness, coherence) of the road construction is preserved. The longer the functionality of the asphalt layer is retained, so the longer the lifetime of the road, the higher the "Quality of the bitumen" will have to be.

So this is a "Technical quality". Considerations of this quality against price, environmental costs or other aspects fall outside the quality definition. Furthermore, it is left open for the time being whether the bitumen quality will be (or can be) realized with a "standard" penetration bitumen, or through all kinds of additives or modifications.
The bitumen must contribute, among other things, to the resistance of the asphalt to:

- Permanent deformation;
- Cracks (bottom and top of the asphalt);
- Ravelling.

The mechanical bitumen properties that play a role are (for example):

- Viscosity;
- Tensile strength;
- Fractional rack;
- Resistance to fatigue.

A clear insight into relevant characteristics and the available variation leads to a more constant process and therefore is important for the quality and the lifetime of asphalt. Linked to this is the question if and how better quality is "rewarded" for the actors in the process.

The project group will start to look into the characteristics and variation within the standards. Next the project group will gain insight into the required characteristics at asphalt plants and the available variation in these numbers. Following on from Germany, a set-up can be made in which various (extra) characteristics of bitumen are

measured and reported on a regular basis. This needs combined effort to obtain data on bitumen quality collected by suppliers, producers and clients. This creates an important database.
The next step is to determine which specification, based on all the knowledge obtained , must be imposed on the specific binder, depending on the application. In addition to insight into the technical properties, also knowledge of properties in relation to the environment and project conditions is important.

The main objective is to provide the essential characteristics and the available variation of bitumen characteristics per application type of asphalt concrete in order to improve the quality of asphalt concrete.

PHASE 1
- Defining which characteristic of bitumen is essential for the production of asphalt concrete (ultimately resulting in, where necessary, an inclusion in the CE marking / DoP from the supplier);
- Determining per characteristic what the maximum variation is per application;
PHASE 2
- Inclusion of the defined characteristics and maximum variation for bitumen in one national annex to the European standardization or a proposal sent to CEN / TC336 / WG1 (European standard committee for bitumen) and included in an existing European standard.
- Additional technical research may be needed to determine optimal values to be.

Ultimately, it is necessary to examine the economic consequences. Which additional costs must be made by the producer of the binder (including quality assurance, laboratory tests) to achieve the specifications? And what is the profit in terms of LCC for the paving construction?

If the objective has been achieved, it can be seen as an advantage to achieve a level playing field. All bitumen suppliers deliver their products with the same characteristics and within the specified range, which means producers and processors each deliver comparable (high-quality) products on contracts. From a level playing field perspective it is also much more visible for producers and processors as soon as they deliver specific added value on a project with products (asphalt-mixtures) that are better than the minimum product requirements based on a basic requirement set.

7. FUNCTIONAL VERIFICATION AND ACCEPTANCE

Since the introduction of the CE-marking in 2008, the specification and assessment of asphalt properties takes place according to the functional approach. In the Netherlands, this choice was made to anticipate with this to the introduction of integrated contracts with functional or solution-free specifications from 2004. The two developments mentioned (introduction of integrated contracts and functional specification of asphalt) possess a strong mutual dependence.

In practice, this still regularly causes problems in contract relationships between client and contractor. The CE marking is in fact a producer's own declaration that asphalt-mix ’at the gate’ of the asphalt-plant. However, the features stated on the CE-marking are only verifiable after adequate processing of that asphalt in the road.

In the 'old' system, with empiric mix design and requirements, the quality of the paving process was validated by quality control on empiric parameters as void content, compaction grade and bitumen content for instance.
Since the start of CE-marking in 2008 and the choice of functional specifications for mix-design, the quality control system of the pavement in the road did not change. At that point in 2008, this was not a problem, because the actual asphalt-mixes were basically the same in there components. A check at a recipe level gave enough information to validate the quality of the road at that point in time.

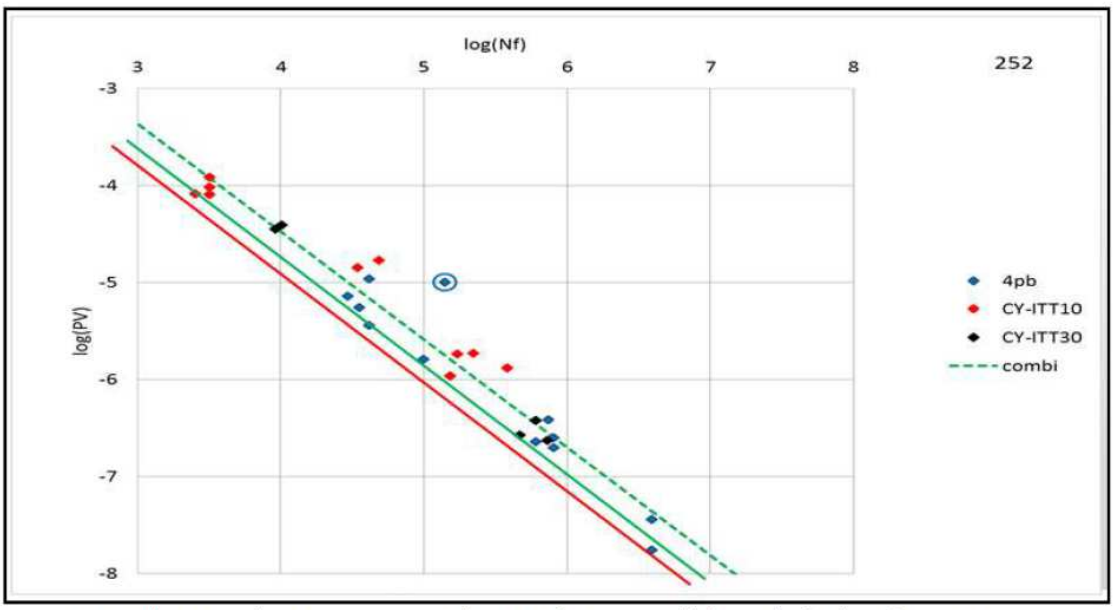
Due to large-scale application of asphalt granulate (environmental consideration), composite fillers and modified binders (pro-long lifetime) and all kinds of aggregates in asphalt, the current quality control on the basis of composition and compaction, tell little over the significant functional quality of the asphalt that is delivered.

The project group of this project aims to come up with a system for functional quality survey for acceptance of the asphalt layer.

Functional verification involves the assessment of the quality of realized work, based on actual objectively measurable mechanical or functional properties of the asphalt. This concerns an essentially different approach than

assessing the quality of work done with the current empirical assessment framework. The properties of the asphalt that have been at the basis of it structural design of a pavement are now indeed actually measured.
On the basis of quantitative data it can be determined to what extent the intended design service life, are met with the actual measured asphalt properties. Shortcomings can be directly translated into lifetime reduction. New in this is that better quality can now be directly translated into functional (extra) value for a client.

There is a need for development of this functional verification system.



Figuur 1: Resultaten analyse vermoeiingsgedrag 4PB & CY-ITT middels methode Shen & Carpenter

Four important conditions apply to successful functional verification of the properties of asphalt:

- The tests will be carried out on the material from the work. These tests for functional verification must have sufficient expressiveness for the characteristics that have been determined in the type-tests and are used in the design-phase of the project. The tests should be carried out on test pieces that are available on the road. The absolute preference is therefore cylindrical test pieces / drill cores ø100-150mm.
- The differences between functional properties measured in the laboratory and properties achieved at work are, with great probability, different from the current empirical characteristics. This means that for functional verification, the safeguards (in the design) and tolerances for the quality assessment must be recalibrated.
- The mechanical properties of asphalt develop strongly in the first weeks after production and processing of the asphalt. The functional verification tests should preferably be able to be carried out in a period of at least six to eight weeks after processing of the asphalt. This is equal to the period in which the type tests are processed, after production of the asphalt. To meet the wish to have a reliable impression of the quality of the asphalt delivered product earlier, and not after about eight weeks after the completion of a work, it is desirable that a theoretical forecasting model (such as included in the PRADO system in Belgium) is being developed for a first rating.
- Because of the abrupt change in 2004 towards functional specifications it now is necessary to set up a long-term monitoring program. Insight is needed in the practical impact of these changes on the performance of asphalt pavements. The main purpose of this long-term monitoring program is to validate the modernized functional technical framework (requirements, methods and systems) for asphalt pavements.

In the end it is the goal of the project group to the develop and implement an uniform and clear system for the functional verification of the quality of processed asphalt.

8. HIGH TECH = LOW COST

Developing a machine learning system for the processing of big data collected for the construction of asphalt layers.

The asphalt supply chain can be illustrated by four main phases. These are (1) asphalt-mixture development, (2) asphalt-mixture production, (3) asphalt-mixture delivery and (4) asphalt-mixture paving and compaction (Figure 1.). From extensive prior research we know that it is necessary to control the process of compaction to decrease over- and under-compacted zones on a road construction site, thereby reducing the probability of having a low quality final product. At the same time the factors that might influence asphalt-mixture quality can be identified on each phase of the asphalt supply chain. At present all phases of the supply chain are considered and or treated as separate processes, where the internal activities on one phase have little or a few clear connection with the activities on another phase.

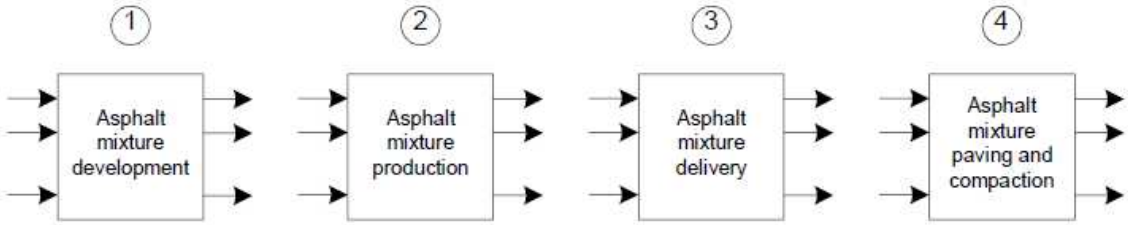


Figure 1: phases of Asphalt supply chain

This Asphalt-Impulse project focuses on developing a MACHINE LEARNING SYSTEM for defined data structures and data flows on each phase of the supply chain. The aim is to identify and quantify the relations between processes in the different phases and various quality parameters of the asphalt-mixture, thus ensuring that clearer connections can be set up between phases and the overall quality more effectively controlled. Artificial Intelligence (AI) and the narrowed concept the Machine Learning (ML) have been rapidly developed for the past two decades. With help of Machine Learning algorithms, massive data sets collected during
construction and the exploitation of different civil objects can be analysed using advanced Data Mining techniques. However, Machine Learning and Data Mining techniques are as yet, not widely used in road construction. This may be due to the fact that data gathering is mostly fragmented and stored separately for different phases of the asphalt supply chain. A few years ago the ASPARi initiative started; Asphalt Sector Professionalising, Research & Innovation. This brought in the Process Quality improvement (PQi).
Currently the Pavement Information Model (PIM) is being developed by some of the larger contractors for centralized data collection from all related sources of the supply chain. These developments combined might serve as useful bases for the development and implementation of Machine Learning algorithms.

The expected outcome is a prototype Machine Learning system that can effectively analyse data sets with defined factors and parameters that might influence asphalt-mixture quality. Analysis of the data collected on one phase of the asphalt supply chain might provide other phases with factors to take into account during design, production, transport logistics, construction and maintenance. Thus concrete and clear connections between phases might be set up, making the asphalt construction process more uniform and structured.

The main objective is to develop a Machine Learning system that will consist of several algorithms applicable for different phases of the asphalt supply chain. To achieve this goal, the appropriate algorithms will be developed, tested and validated on corresponding, relevant datasets. The obtained results will be implemented into relevant phases, making the asphalt supply chain more coupled and structured in terms of data and quality.

9. QUALITY ASSURANCE

Despite the increasing desire for cooperation, the gap between client and contractor seems to be widening. Some clients are more suspicious of the quality delivered and require more testing and enforcement. Contractors consider themselves capable and consider additional and or external control and assurance unnecessary. For the whole sector it is valuable if there is a general agreement for quality assurance, which prevents parties from going their own way and reducing uniformity.

Through better quality assurance by the contractor (ON) and better quality survey (validation) by the client (OG) the asphalt quality outside in the road gets better. With this quality improvement the lifespan is extended and less

maintenance is needed and therefore less CO2 emissions. As an extra plus there is less inconvenience and hindrance for the surroundings and road users .
Through improved quality survey and internal monitoring at the contractor it becomes easier to compare test results with the original demands of the client. This is a way to achieve easier, more efficient and more effective quality survey.

The project group of this Asphalt-Impulse project aims to develop a system of high performance quality assurance, that a client can easily adopt the results as inspection and acceptance on completion of the project. All test that are done will not focus on the end-results, but will be executed in all Phases of Asphalt supply chain. The goals is to get a better controlled, homogeneous asphalt quality in the road with a longer lifespan.

The project group will come up with a specific methodology to upgrade the current control systems of the contractor. This might even include a time-to-time verification by independent quality assurance company. As a basis the system will be in line with the EN1318 normative for the factory production control (FPC). It will be an extension of this; a "Jobsite Application Control (JAC)". In line with the FPC, the asphalt-plant and the contractor perform their own tests. Alongside the contractor, an independent quality controller will verify and validate the outcome of the tests. Enforcement on the part of the client, on FPC and independent quality survey, can make a positive contribution to this.

There is a wish to establish a clear standard quality assurance procedure:
"Which party does when and which sampling and / or inspection and / or testing, and with which methods "?

- Document for the correct implementation of the JAC
- In line with EN13108
- Including systematics for verifying and validating outcome of tests
- Method for;
    - requirements and tolerances
    - checking/verifying (including frequencies)
    - dealing with deviations
- Enforcement by the client
- Collaboration; mutual duties and obligations
- Valuation and optimization

The ultimate goal is to obtain 'first time right'. Non or less hidden defects. Non or less damage in warranty period. No withhold of approval of the project.
This all will result in extra lifetime of the road.

10. SERVICE LIFE PREDICTION MODEL FOR ASPHALT-MIXES

This project consists of three elements: formulating a service life prediction model, realising data tools based on combined (big) data of the entire industry and designing regulations for procurement using these products.
In current practice, the realization of asphalt pavements is a collaboration between client and contractor defined by one of two main contract types;

a. Public private partnerships (PPP) and design-build-finance-maintenance (DBFM)
b. Design & construct contracts and contracts with specified materials and mixes (empirical approach)

In both types of contracts, the quality required by customer has been specified in terms of a predicted lifespan (of roads and/or pavements) or demonstrated "equivalent performance". The accuracy of the current prediction of lifespan is rather poor and based on past performance. This approach results in high risk when innovative mixtures are applied. When contract type 'b' is used this results in a higher risk for the client. While when contract type 'a' a high risk need to be taken by the contractor and possible financiers .

Due to high ambitions with respect to sustainability there is a drive to increase the use of innovative mixtures in asphalt paving. Therefore, there is a need for an improved service life prediction model that is also able to predict performance for non-traditional asphalt mixtures. Such a model would make is possible for both road owners and contractors to apply new mixtures while still controlling risks. Such a model is most effective when it is accepted by both contractors and clients, which requires that the model needs to be easily accessible. If a service life can be predicted with a significant higher level of accuracy, such a model could also play a role in Asset Management and Life Cycle Analyses.

The terminology 'lifespan' needs to be made objective and transparent. This might be done by a predictive model and/or several test methods. This should help the customer with his .

In The Netherlands many asphalt performance tests are available, as well as various models for different kinds of failure mechanisms. But none of these yield a complete understanding of failure of the pavement and a real quantitative prediction of the service life. The concept of the project is to combine the different models available and validate their output with (big) data from the field.

The project group has started with a combined assessment of available data and models. Fortunately, nowadays a lot of data is available, and is being generated every day. Compared to the past, much more data is digitally available and there are more advances data-analyses techniques available that can deal with the vast amount of data coming from a network. Contractors have data of asphalt production, laying and compaction in well-organized data warehouse's. The road managers have periodic inspection data and end-of-life data of the pavement materials, with increasingly higher special detail. Universities and engineering companies have data and models on specific material behaviour. Aggregating and combining all this will create an immense source of knowledge.

SCOPE:
To focus the work within the Asphalt-Impulse program on the current problems in the sector, the following choices are made for the scope:
- Pavement type: noise reducing asphalt, involving (half)open mixes and including SMA's with fine grades.
- Failure mechanism: primarily focus is on ravelling; and skid-resistance. Ravelling and skid resistance are chosen as there is limited insight in this behaviour at this point in time, where ravelling often determines the end of life of a pavement and skid resistance is detrimental for safety.

In the first year over twenty models have been assessed and in a market consultation the most relevant ones were selected to create a proof of concept of a service life model that is able to combine different models with large sets of data.. Currently, this proof of concept is under development. The tool will use Artificial Intelligence strategies to be able to deal with new data as it comes available. Next to this data models are formulated to gather the required data for validation. In this process several data issues require attention. Most notably, metadata are not always of sufficient quality and uniformity. This is a major and time consuming issue in big data analyses.

Parallel to this work technical experts join their knowledge of asphalt-mixes and asphalt pavement with IT-specialists and data-analysts to recognize patterns and correlations in existing data-sets with the aim of formulating trend curves for the service life in practise. Thus big data analyses have been performed on ravelling of porous asphalt roads. A Laser Crack Measuring System (LCMS) has been further developed to be able to measure the surface texture of a top layer on a mm scale and consequently assess ravelling. This tool has been developed to replace visual inspections, however, the raw data contain much more information compared to the previous assessment per 100m stretch. For instance, it is quite important to know if stone loss is homogeneous or concentrated in certain parts (e.g. in the tracks). This is relevant both for establishing the origin of the damage and the remaining service life.
Using smart choices of data, big data analysis methods have been employed to calculate the residual lifetime of the top layers. Whereas in current practice the consistency of the lifetime predictions over two consecutive years is 30 to 35 percent, this number has doubled using the big data analysis techniques, creating more options for optimisation of asset management.
Further results are two dashboards, one to present information retrieved from contracts and a second to monitor the road quality based on LCMS-data and the quality of these data, for the Dutch highways.

Design of regulations will be performed in a later stage, based on the results of the model track and the data analysis track of this project.

11. CONCLUSION

The general objective of the Asphalt-Impulse program is:
"Doubling the average lifespan of our asphalt roads, halving the variation in lifespan, and halving CO_2 production, at equal or lower costs."

The fact that eight project groups, consisting of experts from the entire industry, have started their collaboration and are working on tools to be able to face the issues of the future is a big step towards attaining the Asphalt-Impulse objectives. First results are encouraging and support the expectation that this new approach is a key success factor to realize the transition to sustainable pavements. Especially the first drafts of a more specific Product Category Rules (PCR) for asphalt is a relevant step forward that will definitely contribute to a more level playing field for sustainable pavements.

ACKNOWLEDGEMENTS

The Asphalt-Impulse project has a very wide scope of parties that contribute. The members of the steering committee are; TNO, Bouwend Nederland-VBW, Rijkswaterstaat, Eurobitume, University of Twente, CROW, Kiwa KOAC, Latexfalt, Provincie Overijssel, NVLB, Ingenieursbureau Rotterdam, Delft University of Technology.