Health & Safety

Maximizing the envelope in asphalt research projects: a case study on the tendering process for test tracks using thin noise reducing asphalt layers

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Abstract

For the development of new asphalt mixtures or determination of “real-life” properties in many research projects, the construction of test tracks is included. As in most cases a fixed budget is available for these test tracks, it is necessary to achieve the best value for money. Ideally, this means selecting the contractor with the most (proven) experience, constructing the test tracks as needed for the project (with the best possible quality), while still respecting the available budget and obeying any restrictions imposed by existing laws on public procurement. As a case study, the tendering process for the construction of different test tracks with so-called thin noise reducing asphalt layers in the city of Antwerp is described in detail. A tendering process in two steps was developed, where only experienced contractors, based on a reference list, were allowed to submit an offer in the second step. By utilizing several selection criteria, like overall comprehensiveness of the offer (and not just the price), technical quality of the proposed asphalt mixtures, and quality of the proposed work plan, a ranking was made of the remaining contractors. Only then, decisions had to be made regarding the actual size of the different test tracks, taking into account the overall budget. In this case, the purchaser had the opportunity to wait until the very last moment with making certain decisions (number and size of test tracks, number of different mixtures …), making it possible to maximize the envelope.

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1. INTRODUCTION

In most larger research projects related to asphalt innovation, the final stage of the project consists of real-scale test tracks where the different mixtures, that were designed and tested under laboratory conditions, are monitored under actual traffic and realistic weather conditions. Examples of some research projects, related to low-noise pavements, where test tracks were constructed and monitored, can be found in [1-3]. In all those research projects, only a limited amount of budget is available for these test tracks, even if they are performed in close collaboration with contractors and road authorities. Generally speaking, the funding authority and involved researchers would like to obtain the best value for money. However, a simple "lowest bid" public procurement procedure is probably not the best approach.
As a consequence of the EU Directive 2004/18/EC, only two approaches of contract awarding are possible; the "lowest bid" and the "Most Economically Advantageous Tender" (MEAT) [4]. When using a MEAT procedure, a scoring rule (or set of selection criteria) needs to be developed as well, either to convert the "price-to-quality" or "quality-to-price". In [4] it is suggested that it is preferable to assign monetary values to quality values that can be added or subtracted from the actual bids. In the period 2010-2013, countries like Poland, Sweden and Belgium used mostly the "lowest price" approach for open public procurement procedures, while Spain, France and the UK have shown a steady tendency of selecting a MEAT procedure [5]. In the Netherlands, Rijkswaterstaat, which is part of the Dutch Ministry of Infrastructure and Environment, has used MEAT more and more and has been an early user of this so-called Best Value Procurement (BVP) [6].

In this paper, the tender procedures of two low-noise pavement research projects, both executed in Belgium, are analysed and compared. In order to maximise the available envelope and increase the construction quality (and obtain reliable measurement results), an innovative two-phase tender procedure was used in the second project. As discussed in a recent review paper on innovation and public procurement [7], innovation in the public procurement process can be used as a tool to stimulate innovation. In this paper, three main literature streams were identified: (1) public procurement for innovation (PPfI), (2) public procurement of innovations (PPoI), and (3) innovative public procurement (IPP). The procedure described in this paper can be qualified as a mixture of both PPfI and IPP. The tender procedure is, however, a complicated matter, where different laws on public procurement have to be followed, ensuring that most researchers are unaware of the potential and necessity of an innovative public procurement process for the success of their research project. Ideas and conclusions from this paper are not only valid for low-noise pavement research projects, but for all (asphalt) research projects where test tracks play an important role.

Therefore, in section two, a first low-noise pavement research project is discussed in order to learn from the previous tender procedure and to determine which aspects should be improved. In section three, the STOLA project is described, including the research goals, used tender procedure, selection and award criteria and finally some more information on the implementation of an action plan. A summary of the results from the actual tender procedure and description of the selected test locations are included in section four. The main conclusions of this paper are given in section five.

2. LESSONS LEARNT

Experience with Thin noise reducing asphalt layers (TAL) has been limited so far in Belgium, as results from only one earlier test project were available. The Flemish Agency for Roads and Traffic (AWV) wanted to investigate if TAL could be integrated in their future road policy as a noise reducing measure for regional roads and highways. In 2012, ten test sections were installed on the regional road N19 Turnhout-Kasterlee by two different Belgian contractors. A stretch of 2 km long was divided into ten sections of each 200 m in length, with two sections used as reference surfaces. The first reference surface is a Stone Mastic Asphalt with a maximum aggregate size of 10 mm (SMA-10) and the second reference surface a Double-layer Porous Asphalt Concrete (DPAC), which is considered the most efficient commercially-available mixture in terms of noise reduction. The eight remaining sections were paved with TAL. Two test sections were paved with the same TAL, but with a different thickness (25 and 30 mm), to evaluate its possible influence on the results. These test tracks were then monitored for a period of 3 years. A detailed description of this test project, details on the construction process, laboratory results for resistance to ravelling and interlayer bonding (adhesion), and in situ determination of both acoustical quality and durability can be found in [8-12].

As some of the results from this project were less than satisfactory, also the tendering and construction process were analysed in detail in order to learn more about all these aspects, and not only from the measurement results. The main issues can be summarized as follows:

- Limited interest from the Belgian contractors (only two), and no interest from the neighbouring countries, where more experience with TAL is available;

- Disappointing acoustical durability, mostly linked with premature ravelling, which lead to the replacement of a number of the test tracks only three years after construction.

The limited interest of other Belgian or foreign contractors could be related to the following aspects of the tendering process:

- One contractor is appointed for all the general works, such as the milling works and construction of both the base layer and two reference sections. He is also responsible for the overall coordination with the other contractor(s);
- The individual test sections are allotted to a contractor for a fixed lump sum of 20000 € for one test track of 1400 m² (7 x 200 m), and lowered to 15000 € per test track if the contractor installs up to four different test tracks;
- The contractor has to guarantee a certain maximum noise level after installation, and after two years, according to the Statistical Pass-By method (SPB – according to ISO 11819-1 [13]). The goal is to reach at least a 2 dB reduction compared to the reference SMA-10. If the guaranteed values are not reached, a fine has to be paid by the contractor.

This tendering process might have not been appealing to the majority of contractors, as the risks could be quite high. As they have limited experience with TAL, it is very difficult to guarantee a certain maximum noise level, and chances are high that they have to pay additional fines if they do not reach these levels. For the foreign contractors, who have a lot of experience and related test results, giving these guarantees is not an issue, but we assume that the budget per test track was too low for their additional transport and travel expenses (for both equipment and personnel). This was later confirmed, when we received prices for the TAL from Dutch contractors, ranging between 14 and 23 €/m², leading to an average cost of 18.5 €/m² and a cost for one test track of 25900 €, considerably larger than the available 20000 €.

The other main issue, related to the resistance to ravelling and subsequent acoustical durability, is probably influenced by a number of factors during the construction stage:

- Selection of the type of TAL (high percentage of air voids ➔ higher noise reduction, but more susceptible to ravelling);
- Non-ideal weather conditions (e.g. heavy rainfall during construction);
- Limited experience from the contractor (e.g. importance of compaction temperature and tack coat);
- Limited monitoring during the construction process.

All the above issues, can lead to a lesser compaction degree or reduced adhesion between base and top layer, which will cause ravelling.

3. STOLA project

This section includes a description of the research goals, followed by the developed tender procedure, details on the used selection and award criteria and finally two suggestions which can improve the quality of the construction.

3.1. Research goals

The City of Antwerp initiated this research project as part of their noise action plan, published in March 2014, which was drafted in response to the European Directive 2002/49/EC. Furthermore, as included in their Mobility plan "Antwerp 2020 / 2025 / 2030", all streets in Antwerp will be divided into two groups depending on their mobility function: streets in residential areas with a speed limit of 30 km/h, and the main access roads with a speed limit of 50 km/h. These main access roads will have to cope with even more traffic in the future, while a lot of people live next to or close to these roads. Therefore, the main research goals of this project were:

- Applicability of TAL in an urban environment for these main access roads, with slower traffic, crossing streets, parking spaces, … and a minimum expected service life of 5 years;
- Noise reduction at 50 km/h of minimum 3 dB at the time of construction and after two years minimum 2 dB, compared to an SMA-10, which is currently the standard asphalt mixture in Antwerp;
- Support for fundamental research (e.g. test track with a poro-elastic road surface or PERS) and expertise from abroad.

In order to help the City of Antwerp to achieve these goals, a public tender was published in May 2014 [14]. The candidates had to demonstrate their expertise and experience with previous research projects related to noise reducing pavements. A consortium of University of Antwerp (EMIB research group) and the Belgian Road Research Centre (BBRC), division of Surface characteristics – Markings – Noise (SMN), was awarded this assignment. Additional support was given by AWV for specific measurements (e.g. skid resistance) and in the overall selection process. The project was denominated "STOLA – Stille TopLagen voor Antwerpen" (in Dutch, "Noise reducing top layers for Antwerp").

3.2. Tender procedure

In order to, hopefully, attract more attention from experienced (foreign) contractors, while allowing additional time for important decisions, an innovative two-stage tender procedure was developed. An important prerequisite for the complete tender procedure is its compliance with the Belgian public procurement law and related royal decrees. As shown in Figure 1 (left), the traditional way of tendering requires certain decisions to be made immediately at the start of the process. Both the selection of the test location(s), decisions on number and length of the test tracks (minimum 150 m, preferably 200 m), and even the full description of the type of the asphalt mixture (thickness, desired mechanical/acoustical performance, …) need to be completed before the tendering documents can be drafted and sent to the contractors. This is considered as "bidding the project" where the contracting authority has specified the complete project, including all quantities, and the contractor with the lowest bid wins. In this project however, we chose the concept of "bidding the envelope", where the contracting authority has a maximum budget that it wants to spend, and quantities (or amount of test tracks) are adjusted according to the received offers, which can lead to a higher value for money. Both concepts are explained and investigated further in [15].

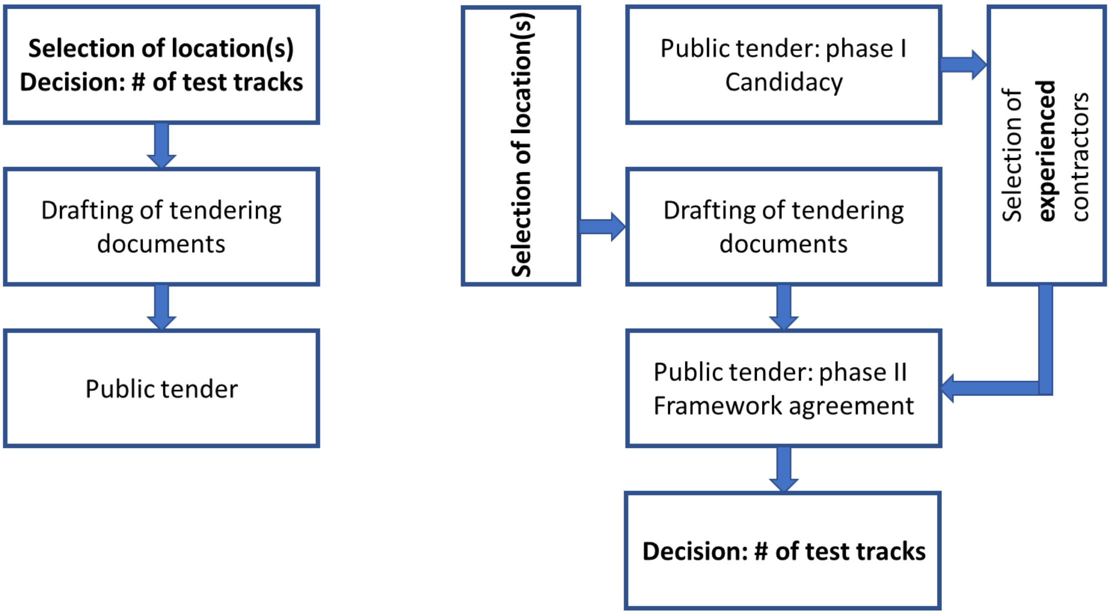

Figure 1: (left) traditional tender procedure – (right) innovative two-phase procedure

In a test project however, it is beneficial to be able to leave certain decisions for a later stage, in order to get the best price/quality ratio and to utilize the available budget to the maximum. The developed two-stage tender procedure [16-17], Figure 1 (right), shows that the tender procedure could be started already without knowing the exact test location, and allows for certain decisions to be made after the contractors submitted their offers, which enables the contracting authority to "maximize the envelope".
Specifically for this project, a maximum budget of 500000 € was available for the construction of the test tracks at two different locations. It proved to be difficult and time-consuming to select these test locations, as explained in [18-19], but this was not an issue as the two-stage tender procedure could be started without this knowledge. A full description of the selected test locations and used TAL (dense or semi-dense), and results from surveys and several in situ measurements taken at different moments after construction can be found in [17-20].

The first stage of the tender procedure, see Figure 2 (left), consists of a candidacy. Contractors who are interested in the project can easily apply and only have to provide a list of references, limited to the past five years, with the following details: total cost, location and date of the reference project, and brand name, # m², type (open, semi-dense or dense) and thickness of the TAL (in cm). For the contractor a limited amount of time is needed (compared to providing a full offer), and for the contracting authority a selection can be made solely based on the expertise and experience of the contractor. After this first phase, a maximum of five contractors will be allowed to proceed to the next phase.

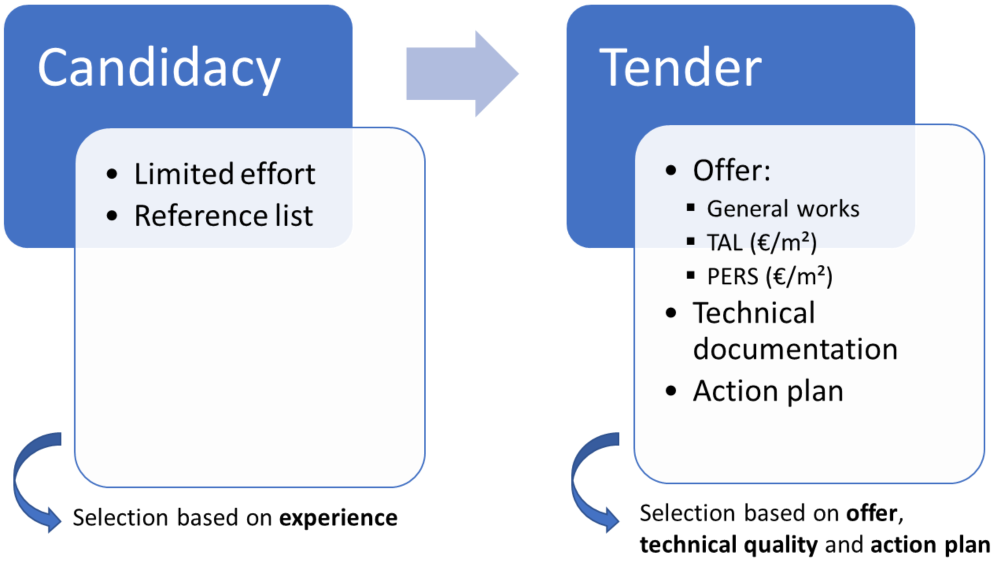

Figure 2: Input from the contractor in the tender procedure (left) Candidacy – (right) Tender

In the second phase of the tender, Figure 2 (right), the contractor is asked to provide an offer, but is allowed to decide freely for which non-mandatory subtasks an offer is made. The complete test project consists of the general works (milling, foundation, base layer, reference SMA-10, sewage system and site signalling), placement of TAL (including tack coat), and optionally a small test section with a PERS.

Furthermore, the contractor is asked to provide detailed technical documentation regarding the proposed TAL mixtures, including results to estimate both the mechanical and acoustical quality. The mechanical quality could be shown by laboratory results for the ravelling resistance, or by the actual service life of the proposed TAL in previous reference projects. The acoustical quality could be proven by SPB or Close ProXimity (CPX – according to ISO 11819-2 [21]) results, or the so-called C_{wegdek}, a specific parameter which describes the acoustical quality of Dutch low-noise pavements[1]. Finally, a detailed action plan for the construction of the TAL is requested, as described in Section 3.4. This second phase also comprises a negotiation procedure, including a best-and-final-offer (BAFO).

3.3. Selection and award criteria

The most suitable candidates after the first phase (maximum five) were selected as follows. After checking the administrative formalities, the reference lists of all the remaining candidates were analysed in detail. Only references where TAL (with a maximum thickness of 3 cm) were installed in the past five years were taken into account. Standard SMA-type mixtures were not considered as acoustically optimized and therefore not accepted. Furthermore, the representativeness [80%] and reliability [20%] of the references were estimated. References which were monitored acoustically in time, in a similar urban environment and speed limit, were valued higher. The reliability could be proven by certificates of proper execution, and other documents which demonstrate the satisfaction of the client and/or the quality of the work. These selection criteria match with *Past Project Performance*, which was identified as one of the most important criteria in [22], together with *Technical Expertise* and *Cost and Management*, both rated during the second phase of the tender.

After the second phase of the tender, a framework agreement is made with the three best ranked contractors on the basis of three selection criteria: the comprehensiveness of the offer [40%], the action plan [35%] and the quality of the proposed TAL [25%]. As mentioned above, each contractor could choose for which non-mandatory subtasks an offer is made. A contractor who gives an offer for the general works, proposes multiple sufficiently different TAL and is willing to construct a PERS test track, will receive a much higher score than a contractor who is willing/able to construct just one type of TAL. A more detailed and comprehensive action plan will lead to a higher score, but the tenderer is bound by this action plan during the execution of the work. Finally, the quality of each proposed TAL is analysed, looking for an optimal balance between noise reduction and durability.

The reason for creating a framework agreement with three contractors is to increase the chances for participating contractors. Each of the best ranked contractors will be awarded at least two test tracks (one TAL mixture, placed at two different test locations). The allocation of the different subtasks is realised using the following award criteria:

- General works: allotment to the lowest bidder (who may not be the best ranked contractor);
- TAL test tracks: allocation using a combination of price, acoustic and mechanical quality;

[1] https://www.infomil.nl/onderwerpen/geluid/regelgeving/wet-geluidhinder/wegverkeerslawaai/akoestisch-rapport/cwegdek/

- PERS test track: allotment to the lowest bidder (only if the total budget is sufficient).

As shown in Figure 1 (right), the decisions regarding the number and type of TAL to be placed, could be delayed until all BAFO were analysed, three contractors were selected and with respect to the overall available budget.

3.4. Action plan

As discussed in section 2, the construction stage is even more important for the end result in the case of TAL, as TAL are more susceptible to ravelling. Therefore, an attempt was made to have a better guarantee on the final pavement quality by two methods:

1. Increased monitoring of the construction stage by the members of the research consortium. This included visual observations, infrared measurements to check the homogeneity of the temperature behind the finisher, analysis of the asphalt cooling process by thermocouples placed inside the top layer, density measurements using a nuclear density gauge and sampling of the asphalt mixtures for further analysis in the laboratory (grain distribution, bitumen content and ravelling resistance). For further details see [17,23];
2. Implementation of an action plan during the tender procedure, which is discussed further below.

The purpose of the action plan is to have guarantees from the contractor in terms of continuity of supply, used equipment, construction procedures (minimum temperatures, weather conditions, tack coating, etc.), experience and presence of site personnel, risk analysis (e.g. back-up equipment), etc. In an elaborate document (ranging from 5 to 15 pages), the contractor describes how the TAL will be placed, including e.g. the necessary minimum amount of tack coat and minimum environmental and compaction temperatures. They also describe when they will start with the paving of the TAL, e.g. when two trucks are on site, or only when all necessary trucks are on site. This is important as any delay during the paving and compacting process can lead to a decrease in temperature and following “weak spot”. Finally, in the risk analysis they describe how they will react to certain risks, e.g. failure of a roller, clogging of the spray unit, expected rain, …

A more elaborate and complete action plan would lead to a higher score in the tender process. However, in order to avoid artificial embellishment, the contractor is bound to this action plan during the execution of the project. In other words, promises made in the action plan, will be used against the contractor if they would deviate from the original action plan without prior agreement from the contracting authority. This way the experience of the contractor can be used in an optimal way as they should know best how to install their own type of TAL. Therefore, no information on the tack coat (type or amount) or optimal temperatures was included in the technical specifications, as the contractors had to provide this in their own action plan. In theory, this would also give the site supervisor better tools to interfere, e.g. to stop the paving process when it starts to rain, as it was described by the contractor in the action plan.

4. Results and discussion

4.1. Tender procedure

The first phase of the tender procedure proved successful as nine different contractors submitted their candidacy (compared to two for the N19-project, discussed in section 2): six from Belgium and three from the Netherlands. After reviewing their candidacy and reference lists, four contractors were selected and admitted to the second phase of the tender: one from Belgium (VBG – Colas Group) and three from the Netherlands (BAM Wegen, Dura Vermeer and Rasenberg Infra).

After analysis of the submitted tender documents for the second stage, a framework agreement was made with VBG, Dura Vermeer and Rasenberg Infra. As explained in section 3.3, the different subtasks were allocated as follows:

- General works: VBG (lowest bidder);
- TAL test tracks: three tracks allocated to VBG, three to Dura Vermeer and two to Rasenberg Infra;
- PERS test track: VBG (lowest bidder).

The amount of TAL test tracks was optimized, taking into account the available length at the selected test locations, see section 4.2, and the available budget. The PERS test track would not have been allotted to the lowest bidder, if the remaining budget was not sufficient. In the end, the budget of 500000 € was maximized almost completely, as the different subtasks were granted for a total sum of 462231 €, including an extra margin of 5-10% for additional works or an increase in quantities, leaving a sum of 37769 € for unforeseen extras during the construction stage.

Furthermore, although the selection of the test locations took more time than anticipated, the overall planning of the project could be maintained. This was only possible by using the proposed two-phase tender procedure, giving us more time to select the test locations, while the tender procedure was already initiated.

Regarding the action plan, we noticed during this project, that both the appointed site supervisor and most of the site personnel of the contractors were not even aware that such document existed. Future use of such an action plan in more projects should help all involved site personnel to use and value this document as an additional tool, and not just as an additional administrative burden.

Finally, as two of the contractors had plenty of experience with TAL in the Netherlands and VBG used TAL mixtures developed in France by COLAS, the additional research goal to acquire expertise from abroad was clearly achieved by this tender procedure.

4.2. Selected locations

As the main goal of the project is to evaluate the effect of TAL in an urban environment two locations were selected in the city of Antwerp and its nine districts [19]. Different streets were selected in a first list (minimum length of 600m), already equipped with asphalt, preferably as straight as possible with a limited number of side streets. As surveys will be used as well to evaluate the effect of TAL in an urban environment, it is important that the situation before the installation of TAL is not leading to a high amount of noise related complaints. This means that the present road surface should be in a moderate to good state, and that the street should not be close to other noise sources such as an airport, railway, industry or highway. Some of these factors were on the "wish-list" in order to be able to perform the necessary acoustic measurements. The street should also have a speed limit of 50 km/h, with no schools or other areas with a reduced speed limit, and preferably no round-abouts or speed humps. For budgetary reasons, it would be beneficial if the base layer is still in good condition.

After a long selection process with the occasional setbacks, such as the presence of cobble stones or tar in the base layer, or a political refusal to cooperate, two suitable locations were eventually selected. Test location A is located at the Zandvlietse Dorpstraat in Zandvliet, one of the districts north of the city center. It is a calm street with mostly detached houses, see Figure 3, and a maximum of 500 vehicles passing through the street on a single day. Only a very limited number of heavy vehicles passes through this street. It is located about two kilometers away from the Antwerp harbour, with all its industry, the A12 highway and a railway.

Figure 3 – Zandvlietse Dorpstraat in Zandvliet (*Photograph by C. Vuye*) (taken from [19]).

Test location B is located at the Kleine Doornstraat in Wilrijk, the most southern of the Antwerp districts. This street contains mostly row houses, or semi-detached houses, and has a higher traffic intensity with a maximum of up to 5000 vehicles passing through the street on a single day in one direction. As can be seen on Figure 4, the street consists of two seperate lanes. A larger number of heavy vehicles and busses pass on this location. The street is located less than one kilometer from the E19 and A12 highways and about five kilometers from Antwerp airport.

Figure 4 – Kleine Doornstraat in Wilrijk *(Photograph by A. Bergiers)* (taken from [19]).

At both test locations five different test tracks are installed, see Figure 5 and Figure 6. At test location B, the original road surface, a Dense Asphalt Concrete 0/10 (DAC 10), installed in 2012 by Aswebo, was still in a good shape so it was kept as a reference surface. The SPB-locations are marked here with small purple dots.

Figure 5 – Test tracks installed at test location A (taken from [19]).

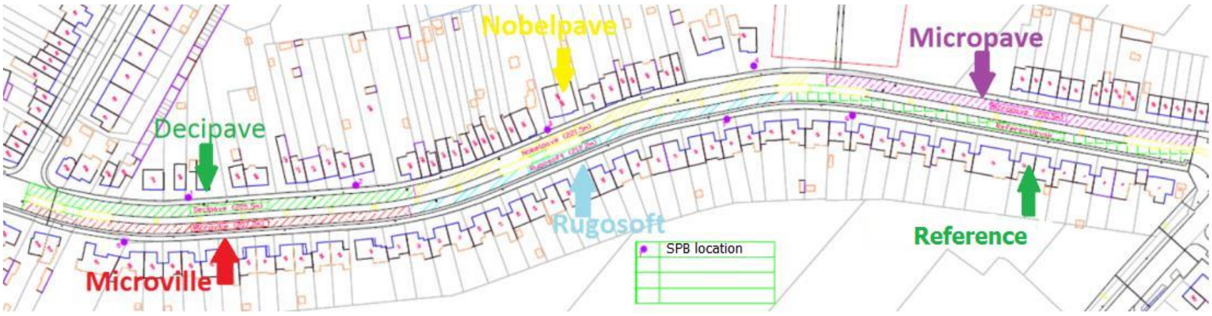

Figure 6 – Test tracks installed at test location B (taken from [19]).

The thickness for all TAL is max. 3 cm, while the SMA-10 is placed at a thickness of 4 cm. Unfortunately, due to very stringent weather conditions during installation, the PERS test track was not placed and was replaced by an SMA-6.3. Further research using prefabricated PERS slabs is ongoing, including a recently installed test track in Gent (Belgium) [24-25].

Both the acoustical and the mechanical properties of these test tracks are monitored for at least three years. The acoustical quality of the TAL is the main focus of this trial, but also other characteristics like rolling resistance, durability (resistance against raveling) and skid resistance have been studied. For actual results, see [17-20].

The construction stage itself was vigorously monitored in order to be able to relate certain defects or differences in acoustical behaviour to events which occurred during the paving process, see [17,23]. We highly recommend that site supervisors at least monitor the environmental and compaction temperatures more closely, even when using a handheld thermometer, and take random samples during the compaction stage, which may or may not be tested further in the laboratory. As mentioned before, the concept of a detailed action plan showed great potential, but in this case, it was not used in an optimal way during the construction stage.

5. CONCLUSIONS

Although the selection of the test locations took considerably more time than expected, the proposed two-phase tender procedure enabled us to look further for suitable test locations, approved by all involved parties, while at the same time contacting the contractors. This way, the overall planning of the test tracks was not delayed.
By using a candidacy as the first phase, only contractors with proven experience were selected, reducing also their workload and giving the contracting authority more reliable offers in the second phase. Furthermore, the "bidding the envelope" procedure allowed us to wait with certain decisions (amount of TAL test tracks, PERS test track Yes/No) until the best and final offers were analysed and to maximize the available envelope.
It is shown that an innovative MEAT procedure is possible, even with the restrictions related to the laws on public procurement. By using a well-thought set of selection and award criteria, the contracting authority gains a lot of freedom, instead of allotting the project simply to the lowest bidder. This not only increases the value for money, but we believe that it can also increase the quality of the construction, and therefore provide more reliable results.

Finally, by monitoring the construction process more closely and verifying a previously submitted action plan, both the contractor and the contracting authority are made aware of certain important aspects, such as the weather conditions or temperatures during compaction. The use of an action plan as part of the tender procedure has many advantages, such as allowing the contractor to demonstrate their expertise, quality of personnel and equipment, but also makes it a shared responsibility. Instead of prescribing, e.g., a certain amount of tack coat, or a minimum compaction temperature, the contractor has to select these parameters himself, ensuring a higher quality, based on his own experience and expertise, and providing the site supervisor with clear tools to interfere. This, however, will only work if the action plan is discussed and used further on site and all site personnel is aware of the content of this document.

The main limitation of this research is that the tender procedure is a complicated matter and that most researchers are unaware of its potential. The initial time investment to determine the whole procedure and necessary selection and award criteria is high, and depends on the willingness of the contracting authority to invest time and personnel as well. The example given in this paper can help to develop a tender framework, even in different research areas, but all tender documents and criteria are case-specific, so a simple copy-paste is never a good idea.

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