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The Netherlands

Hot mix asphalt recycling in the Netherlands The Road to Success

Summary

When the hot mix asphalt recycling in plant was introduced in the Netherlands around 1970-1980 circumstances were favourable for this kind of innovations. The environmental policy, technical development and economic situation contributed to a successful introduction, supported by the highway authorities in the form of cooperation with the contractors in research and large scale trials.

An important condition for the industry to take the challenge for innovations is the expected return on investments. The savings of hot mix asphalt recycling on one hand and the extra costs on the other hand determines this, when comparing with the production of asphalt using 100% new raw materials. The intrinsic value represented of the bitumen and aggregates in the reclaimed asphalt have to be compared with the extra costs for investments in machinery and extra operational costs and costs for quality control. The result of all this depending on the local market situation.

Authorities have the possibilities to create circumstances that will stimulate the recycling and thus also influence the economic balance. High rates for dumping, prescribing hot recycling in specifications and in contracts will trigger market forces. All these elements were implemented in the program to introduce hot mix asphalt recycling in the Netherlands. And with success. Now all asphalt mixing plants in the Netherlands are equipped for hot mix recycling. Almost 70 % of the approximately yearly 3 million tonnes reclaimed asphalt is used in the production of new hot mix. 60 % of all the asphalt produced in the Netherlands (yearly total 7-8 million tonnes) contains reclaimed asphalt.

Research is done in order to use the remaining one million tonnes in hot mix recycling too.

Key words in order to achieve this are availability, quality and functional requirements.

Favourable circumstances for innovations

Innovations, new techniques, they have a chance to be accepted when circumstances are favourable. Especially in a kind of industry that is relatively conservative. And one dares to say that in some way civil engineering in general and road construction in particular is relatively conservative. This means that to introduce a new technique – like asphalt recycling – also circumstances must be favourable in order to have a chance to be successfully introduced. Those circumstances are related – amongst other – to technique, to economy, to public attitude and to general policy.

In the end seventies and early eighties of the last century, the circumstances in the Netherlands were favourable to introduce the recycling of hot mix asphalt on a larger scale. The following aspects contributed to the successful introduction in the Netherlands.

First of all the technical concept of asphalt recycling was available. It was developed in the United States of America after the Second World War when there was a shortage of oil products, in combination with a general - post war - economical crises. Basically the concept of

recycling is very simple: thanks to the properties of the binder, the bitumen. Just reheat the bitumen and it will weaken and it allows you to repave it, to reshape it, to remix it or to recycle it. As a matter of fact it is the same technique that centuries ago people in the Middle East applied to use natural asphalt in their hydraulic constructions, like river banks and water tanks.

Nothing new in this respect. However, what is important in order to have a new technology accepted is that the client, the road authority, is also convinced of the technique and also of the fact that by recycling acceptable and durable products result that comply to the requirements of the client. The idea to use second hand material is not easily accepted. Moreover it requires a lot of nerve to take the responsibility for recycled construction material that is produced out of material that has been disposed of by other road authorities. However, consequently to the Dutch national environmental policy to stimulate recycling, also the policy of the Dutch Directorate-General for public works and water management of the Dutch Ministry of transport was focussed to recycle asphalt to the highest performance level. This government organisation is responsible for the construction and maintenance of the highway network in the Netherlands. In the years of the first large scale experiments with asphalt recycling in the Netherlands the Dutch highway authorities supported extensive trials with recycled asphalt and joined with the Dutch contractors in the technological studies and laboratory research.

Later the complete technical acceptance was achieved when the Dutch Standard Specifications described asphalt based on the use of reclaimed asphalt and accepted this material as completely equivalent to 100% new virgin materials. The example of acceptance by the Dutch highway authorities has resulted in a general acceptance by the other road authorities like provinces and municipalities.

So – summarizing – technical circumstances were in favour for the introduction of this new technique.

Next to technique there was the environmental climate in that period around 1970. In those years a global awareness on environment arose. And since that time environment is an item on national and international agendas. It influences more and more our daily behaviour, as well in our work as in our private life. We are faced with global problems like the glasshouse effect and the consequences of the global warming or the hole in the ozone layer. A Dutch author once described this attitude as “Environmental mentality”. So, in those years around 1970 environmental circumstances were favourable in order to introduce an environmental friendly technique like asphalt recycling.

It was also the problem of scarcity of natural resources for raw construction materials, which stimulated the use of alternative materials. The yearly extraction of large quantities of surface minerals in the Netherlands met more and more with problems and objections. The objections concerned mainly the loss of areas that represent great values regarding nature and landscape. Those of you who know the Netherlands probably recognize that we have no mountains and that our flat country consists mainly of the sediments of the great European rivers and part is reclaimed from the sea. The scarcely quarrying takes place in parts of the Netherlands that are highly valued and appreciated for their landscape. And nature and beautiful landscape is relatively scarce in our highly populated country. This excavation policy – that is the reduction of excavation of sand and gravel for instance from rivers – strongly stimulated attention of the authorities to the application of alternative materials in the building industry and civil engineering.

Next to the excavation policy there is the national environmental policy that forms one of the important incentives for recycling. The starting point of the Dutch environment policy is the

so-called sustainable development: This provides for the needs of the present generation without endangering the possibilities for future generations to provide for their needs too. In the Dutch national environmental policy scheme three main elements were distinguished:

- 1 integral chain management, aimed at the closing of the material chains, in order to reduce waste flows; room for landfills for dumping waste is scarce in the Netherlands;
- 2 Energy-extensification aimed at the reduction of the use of fossil fuels;
- 3 Improvement of quality.

These three elements give directions to the re-use of materials and the application of waste products, such as reclaimed asphalt. Unfortunately we have to use the word “waste” in relation to reclaimed asphalt. The European jurisprudence and the European court decided in several cases that “once a waste always a waste” and this also applies to reclaimed asphalt. Although we know better because reclaimed asphalt is a perfect raw material, a constituent for the production of new asphalt. The fact that reclaimed asphalt is doomed to be a waste has certain consequences for permits, anyway in our country. This has as consequence that environment and environmental legislation also imposes obstructions to developments regarding recycling.

To end the list of favourable conditions in the years of introduction of asphalt recycling in the Netherlands: In the period 1973 and later in the 80's we were faced with the first oil crises that made oil and consequently bitumen scarce and increased the price of bitumen. And because the most important incentive for the industry to introduce new techniques is the financial incentive, these oil crises were very important. This more or less guaranteed to the industry return on investment and on extra cost resulting from these new technologies.

A special incentive in the beginning years was the support of the national highway authority – owner of the motor way network in the Netherlands – in the research during one of the first large scales applications. Later the highway authority prescribed at least 20 % of reclaimed asphalt in their specifications and contracts. The same authority also is responsible for the implementation of the excavation policy, as one of the greater user of mineral aggregates in civil engineering projects and from this responsibility looking for alternative resources. So the support of one of the major clients contributed to guarantee continuity for the future of asphalt recycling and it increased expectation for return on investment.

So summarizing, these mentioned circumstances were the basis for a successful introduction of recycling of asphalt in the Netherlands:

- Availability and acceptance of the technology, cooperation between industry and client;
- Environmental policy and climate: reduction of waste;
- Excavation policy: scarcity of natural aggregate resources;
- Oil crises and high bitumen prices.

Economy

Apart from these specific circumstances at the time of introduction in the Netherlands, there are the more general economic discussions on the use of recycling. In other words how do we determine the economic advantages of asphalt recycling? To determine this it is necessary to compare the savings with the extra costs that are related to asphalt recycling.

The savings are based on the composition of the reclaimed asphalt, especially the bitumen content, and the value of the composite constituents – such as the bitumen and mineral aggre-

gates - that they replace. Of course this is depending on local market prices, which may also differ in time.

Extra costs are partly based on the costs for the processing of the reclaimed asphalt. In the case of cold milling of the old pavement the resulting granular reclaimed asphalt with dimensions of maximal 20 mm is directly applicable in the asphalt mixing plant. If the asphalt is reclaimed in big lumps or blocks, then crushing is necessary. Also the transport and possible temporary storage are part of the extra costs before the reclaimed asphalt is delivered at the asphalt mixing plant.

Secondly extra costs, related to the use of reclaimed asphalt, are introduced by:

- extra investment in the asphalt mixing plant in order to make recycling possible;
- extra maintenance of the plant;
- laboratory tests on the quality of the reclaimed asphalt;
- lower production capacity of the plant;
- extra energy consumption.

Of course all these factors are very much depending on the local situation, but they all have been taken into account.

An answer on the question whether or not the balance is in favour for recycling of asphalt is again depending on the local situation and besides that time depending.

In any case there will be positive contribution in the direction of recycling if there is reclaimed asphalt available and even better if a future availability of reclaimed asphalt is guaranteed.

Also higher cost for dumping of asphalt in landfills is a factor that has a positive influence in the direction of recycling.

And finally possible other low level applications for reclaimed asphalt, for instance unbound use on parking areas or to fill ditches, may be in conflict and in competition with the high level performance recycling in new warm asphalt.

The “Environmentality” of the industry: if there is an environmental awareness and a tendency towards sustainable development this will be positive.

Present situation

When we look at the situation now in the Netherlands regarding the circumstances and instruments that stimulate or keep recycling as a fully accepted daily practice we can mention the following aspects:

- Environmental legislation does not allow the dumping of waste, which can be recycled. So this means that it is not allowed to dump reclaimed asphalt in a landfill for final disposal.
- Dutch specifications allow up to 50 % of reclaimed asphalt in most of the mix types
- Some clients prescribe in their specifications a minimum percentage of reclaimed asphalt in tenders.
- The infrastructure in the form of mixing plants capable to recycle is available.

All this has as a consequence that recycling of asphalt is common practice and fully accepted in the Netherlands.

Some facts and figures

The yearly production of asphalt in the Netherlands is 7 to 8 million tonnes.

Approximately 50 stationary mixing plants produce this quantity.

All these plants are equipped to recycle reclaimed asphalt.

The Dutch road contractors own these mixing plants. In most cases two or more contractors participate in one mixing plant.

Now a days yearly about 3 – 3.5 million tonnes of reclaimed asphalt is coming free from maintenance and reconstruction on asphalt roads.

Table 1 shows the development over the period 1989 to 2000 regarding the use of reclaimed asphalt. It shows that now yearly about 2 million ton of reclaimed asphalt is used in the production of new asphalt. All these figures refer to the application in stationary asphalt mixing plants. So called recycling in plant. Recycling in situ is not very commonly applied in the Netherlands.

Table 1: Development of hot mix recycling

Year	1981	1987	1990	1993	1995	1996	1997	1998	1999	2000
Reclaimed asphalt Used in hot mix [million tonnes]	0.1	0.3	0.5	1.0	1.6	1.8	1.8	1.7	2.2	2.0
Total production [million tonnes]		7.4	7.5	6.5	7.4	7.7	8.1	7.5	8.4	7.6
Percentage reclaimed asphalt in total production [%]		4	7	15	22	23	22	23	26	26

Table 2 shows the different mixes and the percentages of the total production and the average percentage of reclaimed asphalt (for the year 2000) in the various mix types.

Table 2: percentage of total production and reclaimed asphalt in mix

Year	1993	1995	1996	1997	1998	1999	2000	Reclaimed asphalt in mix [%]	Max. according to standard specs. [%]
Mix type									
Base course gravel	36	28	22	19	17	15	14	46	50
Base course crushed	16	25	34	35	38	41	41	44	50
Binder	14	13	11	11	10	9	9	36	50
Dense asph. concrete	21	19	16	18	18	16	17	27	50
Stone mastic	7	7	8	9	9	9	9	0	0
Porous asphalt	6	8	9	8	8	7	6	0	0
Rest	--	--	--	--	--	3	4	-	--

Setting goals

As mentioned the available quantity of reclaimed asphalt is 3 – 3.5 million tonnes every year. After an increase in the last years the yearly quantity that is used in hot asphalt recycling is approximately 2 million tonnes a year (table 1). So there is still an amount of over 1 million tonnes of reclaimed asphalt that is not recycled into hot mix asphalt. How can we explain this and is it possible to fill this gap?

A simple calculation would lead to the conclusion that when we leave out the approximately 0.5 million tonnes of tar containing asphalt waste – which is not suitable for recycling – 50 % recycling of reclaimed asphalt in all mixes (apart from porous asphalt and stone mastic asphalt) would lead to a situation that all reclaimed asphalt could be recycled on an average yearly basis.

The answer can be found in the aspect AVAILABILITY:

Availability at the right place, on the right time, in the right quantity and of the required quality. It is obvious that in the densely populated middle and west part of the Netherlands, with its closer road network, the availability of reclaimed asphalt is in general no problem. In other parts of the country there may be occasionally a lack of this material. This situation may vary during the season and is specially influenced by incidental larger projects. The variation in availability in place and time may lead to transport of reclaimed asphalt under the condition of course that this transport is an economic solution and desirable regarding aspects as environment and energy consumption.

Then the aspect of quality.

As I mentioned earlier an important incentive for the acceptance of asphalt recycling was the fact that in the Dutch standard specification in most mixes up to 50% of reclaimed asphalt is allowed. This is done under the condition that both the reclaimed asphalt and the eventual asphalt mix with the reclaimed asphalt comply with certain requirements.

First of all the requirements of the reclaimed asphalt refer to the following aspects:

- The quality of the reclaimed bitumen from the reclaimed asphalt. This must comply with a certain penetration value or ring and ball temperature.
- The maximum size of the mineral aggregate in the reclaimed asphalt. This must be in relation to the stone size of the eventual new asphalt mix.
- The shape of the mineral aggregate. In this respect one has to realize that in the Netherlands round gravel or crushed gravel is used in asphalt mixes, next to crushed quarry material.
- Contamination, no foreign matter or polluting elements should be in the reclaimed asphalt that influences the quality of the mix
- Tar. Tar containing asphalt is not suitable for hot recycling because of health and environment. It must be removed and burnt to separate the tar from the mineral aggregate.
- Homogeneity. When applied in the asphalt mix the reclaimed asphalt must be homogeneous in order to control the quality of the new mix.

Next to that the Dutch Standard Specifications require that asphalt made with reclaimed asphalt complies with the same quality requirements as asphalt made of 100% virgin constituents/material. So composition boundaries and tolerances are equal. The same for requirements for mechanical properties after compaction.

To comply with these quality requirements raises a problem in order to achieve a full use of all the reclaimed asphalt. To go more in detail on this:

The increasing traffic – higher axle-loads, higher tire pressure, more heavy traffic - requires higher mechanical properties of the asphalt construction and of the mixes. One of the consequences is an increasing use of asphalt mixes with crushed aggregate, with a better resistance

to permanent deformation. Especially in the base course, mixes with crushed quarry material replace mixes that originally consists of round gravel or crushed gravel. The increase over the years is obvious from table 2. It shows that base course material with crushed quarry material since 1993 till 2000 increased from 16 % to over 40 % as the part of the total production. In the same period the total of binder course and base course with gravel decreased from 50 % (= 14 + 36) to 23 %. This development reduced a couple of years ago the use of reclaimed asphalt that came free from older existing pavements, which mainly contained round gravel. The specifications did not allow the use of this material in base course mixes with crushed quarry aggregate. This situation in combination with the fact that – as mentioned earlier – clients also specified a minimum percentage of reclaimed asphalt of up to 50 % created a misbalance in supply and demand. A surplus of reclaimed asphalt with round aggregate and a shortage of reclaimed asphalt with crushed aggregate. Both the client, the road authorities as the industry worked together to find a solution for this problem. Both with their own specific tasks and responsibilities and with their own goals, which may be different, but not conflicting. The road authorities have their responsibilities to fulfil the public environmental goals in combination with the responsibility to take care of a well performing road network. The industry has its environmental responsibility but in combination with their first goal to make profit and see for an acceptable return on investment. In this setting it is important that the road authority gives room to the industry to explore in possible technology and come with solutions.

At the time of the first introduction of asphalt recycling a great impulse for the acceptance was the fact that 50 % recycling was accepted in the standard specification. But with the restriction that recycled asphalt and virgin asphalt had to comply with the same requirements based on recipe and tolerances. The solution for the problem of the surplus of round material had to be found in the approach of functional requirements, or performance based requirements. This approach lead to the research program to investigate, if asphalt for base course, using reclaimed asphalt with round aggregate, could give the same mechanical properties as mixes with reclaimed asphalt containing crushed aggregates. The research program proofed that this was possible for most of the situations. And so the problem was solved and it shows that by a sound cooperation between road authorities and industry those challenges can be met.

Conclusions

The development of the hot mix asphalt recycling was successful, first of all because it was introduced in a period when circumstances were favourable. Technical, economic and environmental incentives were available. The condition for expectance was a close cooperation between client and contractors, at the time of the first introduction and experiments but also in the following period. In this way a solid base for investment was created with perspective fur return on investment and continuity. This created the situation that asphalt recycling could be in conformity with market forces.