THE CYCLING INFRASTRUCTURE IN THE NETHERLANDS

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ABSTRACT: The International Coloured Asphalt Foundation (ICAF) unites experts in coloured asphalt to provide technical guidance to contractors and asphalt plants while inspiring architects and municipalities to explore its potential. In the Netherlands, cycling is a vital part of daily life, with many citizens only appreciating their well-designed cycling infrastructure when faced with less safe alternatives abroad. This article shares insights on enhancing cycling infrastructure and promoting the benefits of cycling to create safer systems globally. We discuss strategies to improve traffic safety and encourage a shift from cars to bicycles, highlighting best practices from various countries, including dedicated cycling lanes and cycling streets. Furthermore, we emphasize the advantages of cycling in urban areas, addressing both economic and health aspects. The article also outlines the significance of coloured asphalt and the positive effects of light-coloured surfaces, such as mitigating the Urban Heat Island Effect, reducing energy consumption, and enhancing visibility for road users through increased light reflection.

KEYWORDS: Promoting Cycling, Cycling benefits, Cycling Infrastructure, Traffic safety, Coloured Asphalt, Urban Heat Island Effect.

1. Introduction

Cycling offers many benefits that enhance both individual well-being and community health. It helps reduce CO_2 emissions and improve air quality, making cities cleaner and more sustainable. Additionally, cycling is excellent for physical fitness and mental health, as it can lift moods and relieve stress. With more people cycling, urban areas can enjoy reduced traffic congestion and better public spaces.

To encourage cycling, having good infrastructure is crucial. The safer and more accessible the cycling paths are, the more likely people will use them. High-quality cycling paths help create a cycling-friendly culture in communities. It's also important that these paths are well-connected, providing easy routes for cyclists. Options like dedicated bike lanes and cycling streets prioritise cyclists, making the roads safer.

Incorporating colour into cycling paths, by applying coloured asphalt, it can further enhance safety and visibility. Coloured surfaces clearly mark bike lanes, making them more noticeable to both cyclists and drivers. By focusing on creating safe, connected, and visually distinct cycling infrastructure, cities can effectively encourage more people to cycle, contributing to a healthier and more sustainable urban environment.

2. Why Promote Cycling?

2.1 Environmental and Urban Benefits

Cycling plays a crucial role in reducing CO_2 emissions and improving local air quality by lowering NO_x and particulate pollution. Fewer cars on the road mean less congestion, reduced emissions, and a healthier urban environment. Additionally, decreasing the reliance on cars frees up valuable space previously used for parking, making room for green areas, parks, and playgrounds - enhancing the liveability and sustainability of cities (Figure 1).

Fig. 1. Dutch Cycling Vision - Environmental and Urban Benefits [Dutch Cycling Embassy, 2023].

2.2 Health and Well-being

Cycling offers significant benefits for both physical health and mental well-being. Regular cycling improves fitness, boosts mood, and reduces stress—especially when compared to the frustration of being stuck in traffic. Studies show that cycling is often faster than driving for distances up to 5 km, making it a practical and enjoyable alternative for daily commuting (Figure 2).

Fig. 2. Dutch Cycling Vision - Health and Well-being [Dutch Cycling Embassy, 2023].

2.3 Road Safety

Cities with fewer cars experience a significant reduction in traffic accidents. Dedicated cycling lanes enhance safety by providing clear, protected spaces for cyclists. In areas with limited space, converting two-way streets into single-lane roads with adjacent cycle paths has proven to be an effective solution.

Oslo, for example, successfully implemented one-way street conversions, leading to fewer accidents. Additionally, enforcing a 30 km/h speed limit further improves road safety for all users (Figure 3).

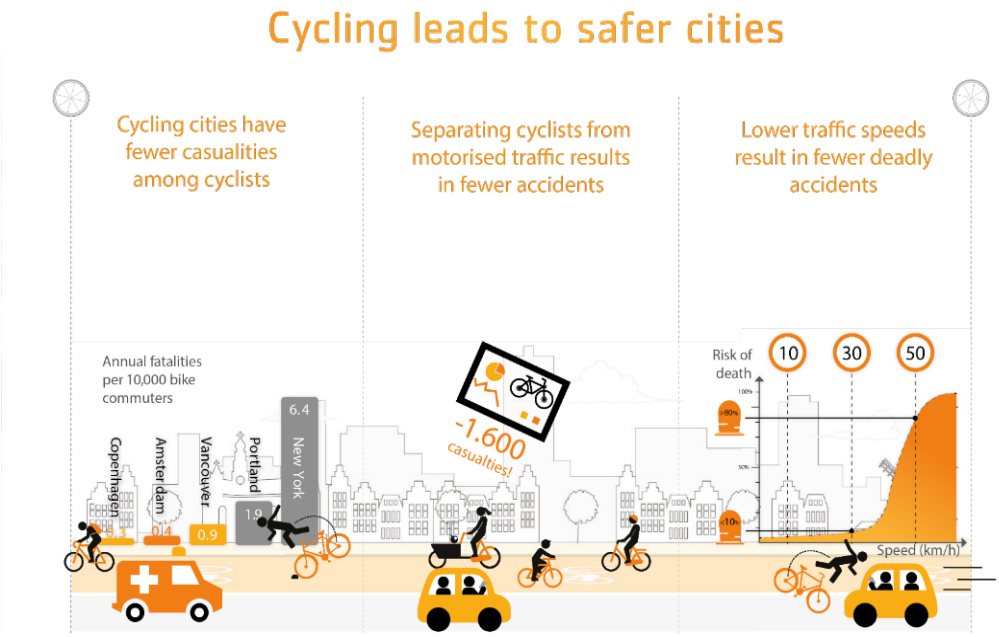

Fig. 3. Dutch Cycling Vision - Road Safety [Dutch Cycling Embassy, 2023].

3. Cycling Infrastructure

3.1 The Origin of the First Cycling Path in the Netherlands

In the 1970s, amidst a growing traffic safety crisis in the Netherlands, the idea for the first red cycling path emerged. Tilburg, under the leadership of Mayor Cees Becht, had the opportunity to participate in a demonstration project for cycling paths funded by the Ministry of Transport and Water Management. Rob Sangen, a young traffic engineer, developed plans for a safe cycling route through the city centre, including bridges and car-free streets.

During the preparations, it was decided that the cycling path should have a different colour than the grey asphalt. Although the aesthetics committee initially wanted yellow, red turned out to be the cheaper option. On April 21, 1977, "The Red Cycling Path" was ceremonially opened by Minister *Tjerk Westerterp*. This marked the beginning of an extensive cycle of cycling path construction in the Netherlands, with Tilburg becoming a model for other cities. The red cycling path became a symbol of Dutch cycling culture and a crucial step in developing safe infrastructure for cyclists.

3.2 Key Design Principles

Designing high-quality cycling infrastructure requires careful planning to ensure safety, efficiency, and accessibility. The following key principles serve as the foundation for effective cycling networks:

1. Safety First – Infrastructure must ensure the safety of cyclists, including children;
2. Speed Limitations – Reducing motor vehicle speeds to a maximum of 30 km/h enhances safety;
3. Direct and Efficient Routes – Cycling paths should be smooth and direct, minimizing delays;
4. Visibility at Intersections – Clearly marked and recognizable bike lanes improve cyclist priority;
5. Minimizing Contact with Cars and Pedestrians – Reducing potential conflict points enhances safety;
6. Connected Network – Infrastructure should link key urban facilities such as schools, parks, and workplaces;
7. Coloured Asphalt for Recognition – Using coloured asphalt makes bike paths clearly identifiable and improves traffic comprehension.

3.3 Types of Cycling Infrastructure

Cycle paths are essentially of three types (two examples are shown in Figure 4):

- Separate Bike Lanes – Dedicated paths fully separated from vehicular traffic for maximum safety.
- Cycling Streets – Common in the Netherlands, where red-coloured asphalt indicates cyclist priority, and cars act as "guests."
- Fast Cycle Routes – Long-distance cycle highways with minimal interruptions, often featuring tunnels or bridges at intersections.

Fig. 4. Cycling street (left) and cycling highway (right) [Dutch Cycling Embassy, 2023].

Separate bike lanes are dedicated pathways exclusively for cyclists, physically separated from motorized traffic. These lanes increase safety because they provide a dedicated space for cyclists, thus reducing the risk of accidents with cars. Typically, separate bike lanes are marked with clear signage and painted lines, often

featuring a distinct colour, such as red, to increase visibility. This design encourages more people to cycle, knowing they have a safe route away from the hazards of road traffic.

Cycling streets, or "*fietstraten*", prioritise cyclists over motor vehicles in urban areas. While cars are permitted, they must yield to cyclists, making the streets feel safer and more accessible for cyclists of all ages. These streets often feature reduced speed limits for vehicles, signage indicating the primary use for cycling, and may include elements like wider paths and additional greenery to create a pleasant environment. Cycle streets bring communities closer together and encourage the use of bicycles as the most appropriate mode of transport.

Fast cycle routes are designed to facilitate longer-distance cycling, connecting urban centres with surrounding areas. These routes typically feature fewer intersections and minimal stops, allowing cyclists to travel efficiently and at higher speeds. Fast cycle routes include dedicated lanes that are physically separated from both pedestrian pathways and motor traffic, promoting safety and comfort for cyclists. These routes are often equipped with clear signage and maintenance and encourage users to choose the bicycle over the car (thus reducing traffic congestion and increasing environmental benefits).

Together, these cycling path designs play a vital role in promoting a cycling culture in the Netherlands, enhancing safety, accessibility, and sustainability in urban transport.

3.4 Before-and-after Situations

In Figure 5 are some before-and-after situations featuring coloured asphalt to clearly demonstrate that good cycling infrastructure leads to a clearer traffic situation.

Fig. 5. The Hague: in 1995 ©Sjoerd van der Hucht (left), and in 2016 ©Frank Jansen (right) [Dutch Cycling Embassy].

The photos in Figure 5 were both taken in The Hague at the exact same spot but in different years. The photo on the left shows the traffic situation in 1995, where coloured asphalt had not been used, and there was no designated area for bicycles. Cyclists had to share the road with motor vehicles, without clearly indicating where they should ride. In contrast, the photo on the right was taken in 2016, featuring improved infrastructure that includes clear markings indicating where cyclists should be, creating a more comprehensible traffic situation.

Figure 6 (left) shows a busy road in Amsterdam (*Javastraat*) in 2010, while the photo on the right-hand side displays the same location with improved cycling infrastructure, resulting in a safer traffic environment.

Fig. 6. Amsterdam (Javastraat): in 2010 ©Claudia van Noord (left), and in 2024 ©Frank Jansen [Dutch Cycling Embassy] (right)

4. Benefits of Coloured Road Surfaces

4.1 Coloured Road Surfaces

Coloured road surfaces are primarily utilized for safety purposes. They enhance the visibility of cyclists, alerting drivers to the presence of vulnerable road users and prompting them to exercise greater caution. By clearly delineating areas designated for different types of road users, coloured surfaces help guide traffic and highlight critical zones that require heightened awareness.

In addition to their safety benefits, coloured road surfaces also serve aesthetic functions. They can help roads blend harmoniously with their surroundings, as seen in locations where the pavement complements natural features like dunes or the beach. Conversely, they can be designed to stand out and attract attention, such as the vibrant yellow bicycle lane in the city centre of Rotterdam, which encourages cycling and enhances the urban experience (figure 7).

Fig. 7. Light-coloured asphalt integrated into the surroundings [Ventraco, 2025] (left), and yellow-coloured asphalt standing out [Dutch Cycling Embassy, 2023] (right).

4.2 Coloured Asphalt

A coloured road surface can be applied using various methods, including coloured concrete, thermoplastic coatings, pigmented micro-layers, and the most effective option: coloured asphalt. Here are some reasons why coloured asphalt stands out as the preferred choice:

- **Quick Installation and Traffic Access**: Asphalt paving is easy to install, allowing roads to be opened to traffic within just a few hours. In contrast, ready-mix concrete requires approximately 14 days before it can bear traffic loads;
- **Durability and Longevity**: Coloured asphalt is known for its durability and long lifespan, lasting many years compared to alternatives like coatings, which typically need replacement every 2-3 years;
- **Recyclability**: Coloured asphalt is recyclable, whereas thermoplastic coatings cannot be recycled, making asphalt a more environmentally friendly option;
- **Low Maintenance**: Coloured asphalt requires minimal maintenance. Unlike brick surfaces, it does not crack due to vibrations, and there are no gaps for weeds to grow between, significantly reducing upkeep efforts;
- **Comfortable Riding Experience**: The smooth and even surface of asphalt enhances comfort for cyclists, making rides easier and more enjoyable. Unlike coated roads, which can be slippery, asphalt provides reliable traction. We've even received feedback from cyclists in Belgium expressing concerns about using coated roads in wet or freezing conditions due to fears of losing grip or control;
- **Variety of Colours**: Asphalt can be coloured in a wide range of colours, making it possible to create eye-catching and functional designs that can enhance urban environments.

In summary, coloured asphalt not only offers practical benefits in terms of installation, durability, maintenance, and safety, but it also provides aesthetic flexibility, making it an excellent choice for modern road infrastructure (Figure 8).

Fig. 8. Weeds in the brick openings [Dutch Cycling Embassy] (left), and wear and tear on the cycle path pavement ©Telko Estonia (right).

5. Light-Coloured Asphalt and Sustainability

As cities strive for more sustainable infrastructure, light-coloured asphalt presents an innovative solution with multiple environmental and practical benefits. By reflecting more sunlight and improving visibility, it helps mitigate climate challenges while enhancing safety and efficiency.

5.1 Reducing the Urban Heat Island Effect

Dark asphalt absorbs heat, significantly raising urban temperatures. Traditional black asphalt reflects only about 4% of sunlight, whereas white asphalt can reflect up to 90%. This increased reflectivity can lower surrounding temperatures by as much as 20%, making cities more liveable.

Table 1 displays the results of a test measuring the temperature of a roof surface under various conditions. It compares the surface temperature and solar reflectance index of a black surface with a white surface. The findings clearly demonstrate that a white surface results in a much higher solar reflectance index and significantly reduces the temperature.

Table 1. Reduction of temperature by light-coloured surfaces [Ventraco, 2025]

CF = ColorFalt V Premium White TSR = Total Sun Reflection SRI = Sun Reflection Index	TYPE OF SUPPORT	RETAINED emissivity			SRI (Excel file BERKELEY)		SRI AVERAGE ON WHITE BACKGROUND (Excel file BERKELEY)	
		mediu m 30"	mediu m 1'	MEDIU M RETAIN ED	SRI value	Roof surface t°C	SRI value	Roof surface t°C
20211108 UNIDENTIFIED TINTED BLACK_3.24%	agglomerated gravel complexion on metallic cover	0,9100	0,9100	0,910	-2	83,1	-1,25	82,95
20211108 UNIDENTIFIED TINTED BLACK_3.38%	agglomerated gravel complexion on metallic cover	0,9000	0,9000	0,900	-2	83,3		
20211108 UNIDENTIFIED TINTED BLACK_3.84%	agglomerated gravel complexion on metallic cover	0,9000	0,9000	0,900	-1	83,0		
20211108 UNIDENTIFIED TINTED BLACK_4,67%	agglomerated gravel complexion on metallic cover	0,9100	0,9100	0,910	0	82,4		
20211108 CLEAR BINDER, LIGHT SAND 2% CF TiO2_34.15%	agglomerated gravel complexion on metallic cover	0,9200	0,9200	0,920	39	68,0	40,00	68,03
20211108 CLEAR BINDER, LIGHT SAND 2% CF TiO2_34.36%	agglomerated gravel complexion on metallic cover	0,9100	0,9100	0,910	39	68,1		
20211108 CLEAR BINDER, LIGHT SAND 2% CF TiO2_35,02%	agglomerated gravel complexion on metallic cover	0,9300	0,9300	0,930	40	67,5		
20211108 CLEAR BINDER, LIGHT SANS 2% CF TiO2_37,35%	agglomerated gravel complexion on metallic cover	0,9200	0,9200	0,920	42	68,5		
20211108 CLEAR BINDER, LIGHT SAND 2% CF TiO2_38,93%	agglomerated gravel complexion on metallic cover	0,9100	0,9100	0,910	44	65,8		

5.2 Energy Efficiency and Cost Savings

Lighter road surfaces not only contribute to cooler urban environments but also reduce energy consumption. They improve nighttime visibility, decreasing the need for street lighting. A case study in Luxembourg showed

that tunnels constructed with white asphalt led to significant energy savings, with investment costs recovered within seven years.

5.3 Improved Road Safety

Among other factors, road safety depends a lot on visibility. In this respect, light-coloured asphalt contributes significantly to the visibility of pedestrians and cyclists, thus minimising the risk of accidents (especially in low light). This makes roads safer for all users, encouraging sustainable mobility choices such as walking and cycling.

By incorporating light-coloured asphalt into urban planning, cities can take a significant step towards sustainability, energy efficiency, and safer public spaces.

6. Pigments for Coloured Asphalt

6.1 Colours and binders

Coloured asphalt is available in a wide range of shades, including red, white, yellow, green, blue, and custom colours. The choice of binder plays a crucial role in determining the final colour:

- Black paving grade bitumen – Commonly used for red and grey asphalt;
- Clear binder – Enables a broader spectrum of vibrant colours, such as yellow, beige, and blue.

6.2 Pelletised *vs.* Powder Pigments

Using pelletised pigments instead of powder pigments in asphalt mixtures provides several. Working with pelletised pigments creates dust-free conditions, which reduces pollution at the asphalt plant and eliminates health risks associated with inhaling fine dust. Additionally, the pelletised pigments recommended by the ICAF enhance the modification of the asphalt and deliver greater colour strength compared to powder pigments. Furthermore, these specific pellets boast a better Environmental Product Declaration (EPD) than the powder pigments.

To achieve the best results with coloured asphalt, several factors must be considered. The production of coloured asphalt requires clean machinery, rust-free surfaces, and careful selection of raw materials. Additionally, during application, factors such as weather conditions, clean equipment, and proper footwear must be considered. Proper execution ensures a high-quality, durable, and visually appealing road surface.

7. Final Considerations

Coloured asphalt is primarily used to enhance traffic safety, but it also serves aesthetic purposes. Increasing awareness and improving visibility help guide traffic, creating a clearer and more comprehensible environment for all road users.

Visibility is crucial for road safety, as light-coloured asphalt significantly enhances the visibility of cyclists and pedestrians, thereby reducing the risk of accidents, especially in low-light conditions. This increased visibility makes roads safer for everyone and encourages sustainable mobility choices, such as walking and cycling.

The advantages of light-coloured asphalt extend beyond safety; they also play a role in mitigating the urban heat island effect and improving energy efficiency.

The advantages of light-coloured asphalt are not limited to safety but also help to mitigate the urban heat island effect and improve energy efficiency.

Ultimately, developing a comprehensive cycling infrastructure is essential for supporting sustainable urban mobility. By making cycling a safe and appealing option, cities can contribute to healthier communities and a more sustainable future. Investing in cycling infrastructure is not merely about providing paths; it is about reimagining urban spaces to enhance the overall quality of life for all residents.

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