

# On the road to sustainability.

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Working towards sustainable traffic safety.

Pavement marking edition – July 2023



# Our commitment Improving every life

## Our world faces unprecedented and accelerating challenges.

As the world's population marches towards 9 billion people, with the greatest growth concentrated in emerging economies, the global community must seek solutions to limited natural resources, lack of access to education and healthcare, inadequate food supplies, rapid urbanisation, stressed water systems and a global climate crisis. It is clear that these global dynamics are challenging the sustainable growth of future generations.

## Imagine a world where every life is improved.

At 3M we believe a sustainable future is one in which ecosystems thrive, communities are safe and healthy and opportunities are equitable and accessible for all people. The challenges we must solve for a sustainable future don't always follow clear rules or methods – but we see them clearly. Collectively, our strategies and goals chart 3M's path forward. Our sustainability strategy is a systemic approach, seeking to drive innovation and holistic impact against shared global needs. We set impactful and measurable goals, demonstrating our environmental, social and governance (ESG) progress.

We know a sustainable future can't be created by one entity, and understand the impact we make in improving our business, our planet and every life can be far greater if done in collaboration with our customers, communities, governments and partners.



All new products strive to show how they will drive impact for greater good.

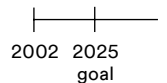


Reduce

**121 million**  
metric tons of  
customers CO<sub>2</sub>  
equivalents

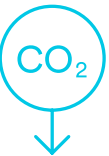


toward goal of  
250 million metric tons

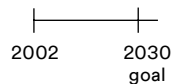


**Scope 1 and 2  
market-based  
emissions**

**37.8%**  
below 2019 baseline



On pace for 2030 goal  
(50% reduction) and 2050  
carbon neutrality goal.

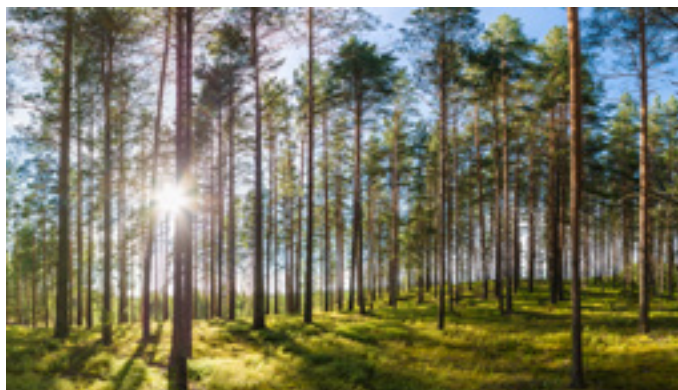




# Accelerating our ambitions

## Science for Circular

Design solutions that do more with less material, advancing a global circular economy.



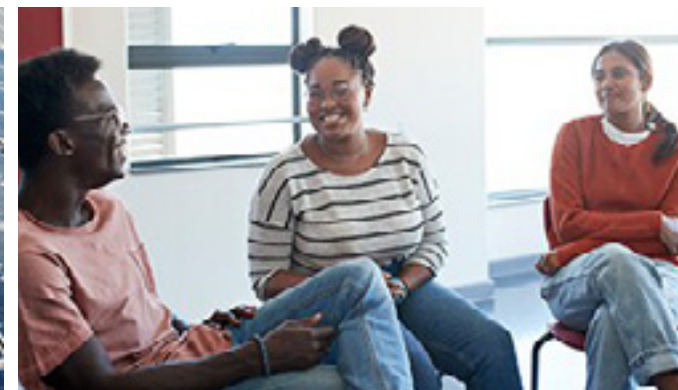
## Science for Climate

Innovate to decarbonise industry, accelerate global climate solutions and improve our environmental footprint.



## Science for Community

Create a more positive world through science and inspire people to join us.



### 2002

GHG emissions reported by WRI/ WBCSD GHG Protocol.

### 2005

**35.5%** Scope 1 and 2 **emission reduction**, 2002 baseline.

### 2015

**69.2%** Scope 1 and 2 **emission reduction**, 2002 baseline.

**39.8%** water efficiency increase to net sales, 2005 baseline.

### 2021

**75%** Scope 1 and 2 **emission reduction**, 2002 baseline.

**49.4%** water efficiency increase to net sales, 2005 baseline.

### 2022

**37.8%** Scope 1 and 2 **emission reduction**, 2019 baseline.

**51.9%** Increased renewable energy use to electricity, 2015 baseline.

### 2025

Reduce manufacturing waste by **10%** and improve energy efficiency by **30%**, 2015 baseline.

Reduce dependence on virgin fossil-based plastic by **56 million metric tons**.

### 2030

**25%** water efficiency increase to net sales, 2019 baseline.

**50%** scope 1 and 2 **emission reduction**, 2019 baseline.

### 2040

**80%** scope 1 and 2 **emission reduction**, 2019 baseline.

### 2050

**Carbon neutrality** Scope 1 and 2 emissions.

# Pavement markings

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# Our promise

At 3M we are dedicated to improving transportation infrastructure and mobility to help motorists arrive at their destination safely. Our high performance materials combine with innovative systems and services to help you bring excellent roadway systems into reality. For over 80 years, we have shared in your mission to help make road networks safer.

Reducing road fatalities and injuries is a priority for all involved in designing and managing our road network. With the volume of traffic due to increase\* over the next few years the challenge will be to keep the increasing numbers of road users as well as road workers safe, manage traffic flows and congestion and balance this against the impact on air quality.

3M has been focused on developing technologies to improve road safety and manage traffic for over 80 years and has been manufacturing reflective sheeting for traffic signs since the 1940s and over the past six decades has introduced a number of innovative reflective sheeting solutions to improve visibility of traffic signs, vehicles and road markings.

**We help bring families home safely.**

## ⤴ Transportation Safety Division Mission

Globally, there are  
**1,350,000**  
traffic fatalities every year.<sup>2</sup>

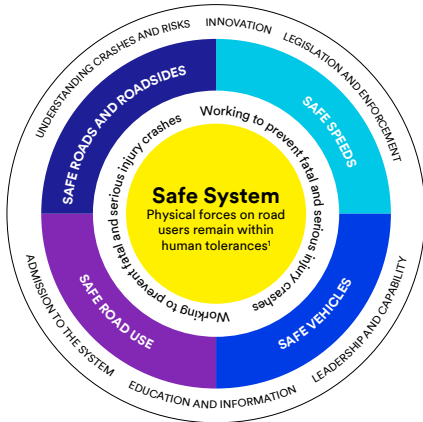


#### Sources :

1 <https://www.reportlinker.com/dataset/9b7d1835c906c10d6dd5a15040b394adc3da8416> - August 2023

2 <https://www.who.int/data/gho/data/themes/topics/topic-details/GHO/road-traffic-mortality#:~:text=There%20were%201.35%20million%20road,those%20aged%2015%E2%80%9329%20years>

# Market trends/customer needs



## Improving road safety

- ▶ Worldwide 1.35M people die every year on the road (CDC)<sup>1</sup>
- ▶ Eliminating black spots
- ▶ Working towards zero deaths
- ▶ Actively looking for solutions to reduce the risk of crashes



### Durability

- ▶ Thermoplastic can prematurely de-bond from concrete<sup>2</sup>
- ▶ Less durable markings must be re-stripped frequently



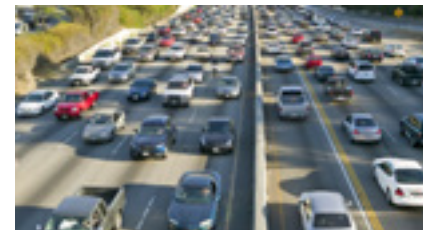
### Aging drivers

- ▶ Globally, the population aged 65 and over is growing faster than all other age groups<sup>3</sup>
- ▶ Older drivers require greater reflectivity than younger drivers<sup>4</sup>



### Night-time visibility

- ▶ Standard glass beads can lose their dry reflectivity quickly
- ▶ Standard glass beads fail to return useful light back to driver in wet/rainy conditions



### Increased congestion

- ▶ 239 cities globally reported YOY increases in congestion<sup>5</sup>
- ▶ Ministries of Transport are moving to more durable markings to avoid frequent restriping



### Low inspection resources

- ▶ Liquid markings install quality is dependent on skill set of applicator
- ▶ Road authorities may not have sufficient resources to ensure pavement markings are meeting specs



### Sustainability awareness

- ▶ Directives to lower environmental impact from central government
- ▶ Reconsidering use of solvent based materials<sup>6</sup>

#### Sources :

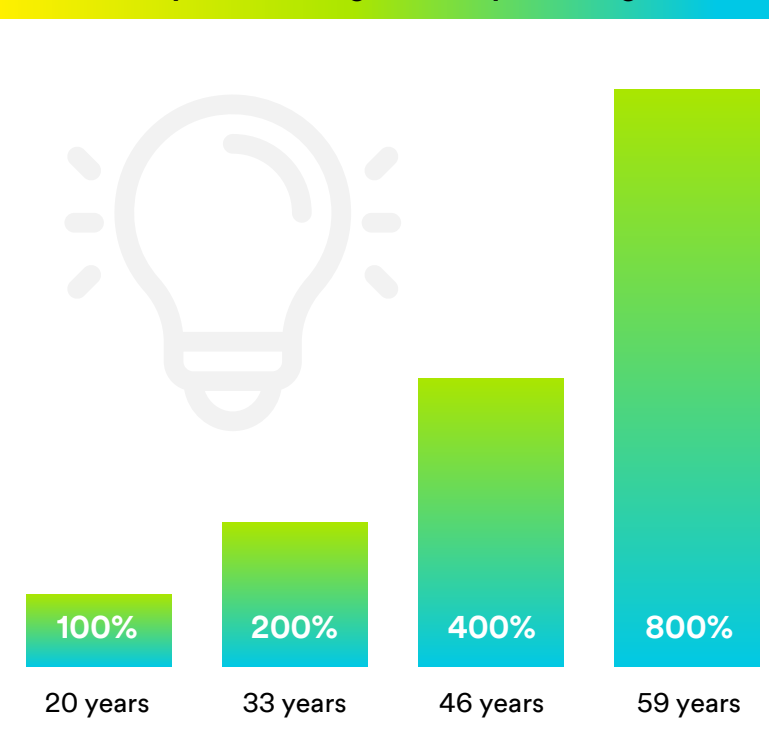
- <https://highways.dot.gov/-/The-Safe-System-Approach> has origins in Sweden through its Vision Zero program and with the Sustainable Safety program in the Netherlands.
- Effective Pavement Marking Materials and Applications for Portland Cement Concrete Roadways, FHWA/TX03/41502
- [www.un.org/en/sections/issuesdepth/ageing/](http://www.un.org/en/sections/issuesdepth/ageing/)
- Enhanced Night Visibility Series, Volume VIII: Phase II Study 6: Detection of Pavement Markings During Nighttime Driving in Clear
- Weather, FHWA/HRT04139
- [www.globenewswire.com/newsrelease/2020/01/29/1976528/0/en/TomTomTrafficIndexGlobalTrafficCongestionUpas](http://www.globenewswire.com/newsrelease/2020/01/29/1976528/0/en/TomTomTrafficIndexGlobalTrafficCongestionUpas)

# Road safety – day and night/dry or wet

## 3M markings meet and exceed all statutory and regulatory requirements (EN 1436).

They are optimised for use on all common road surfaces. Even under high traffic loads, 3M road markings need to be replaced much less frequently than standard liquid markings.<sup>1</sup>

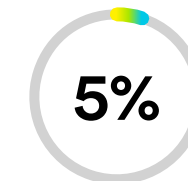
Relationship between age and required brightness<sup>2, 3</sup>



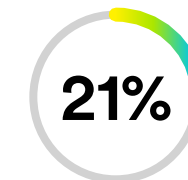
## Statistics on human brightness perception.<sup>2, 3</sup>



of traffic engineering information are perceived by the eye



visual performance of the human eye at night compared to the level during the day



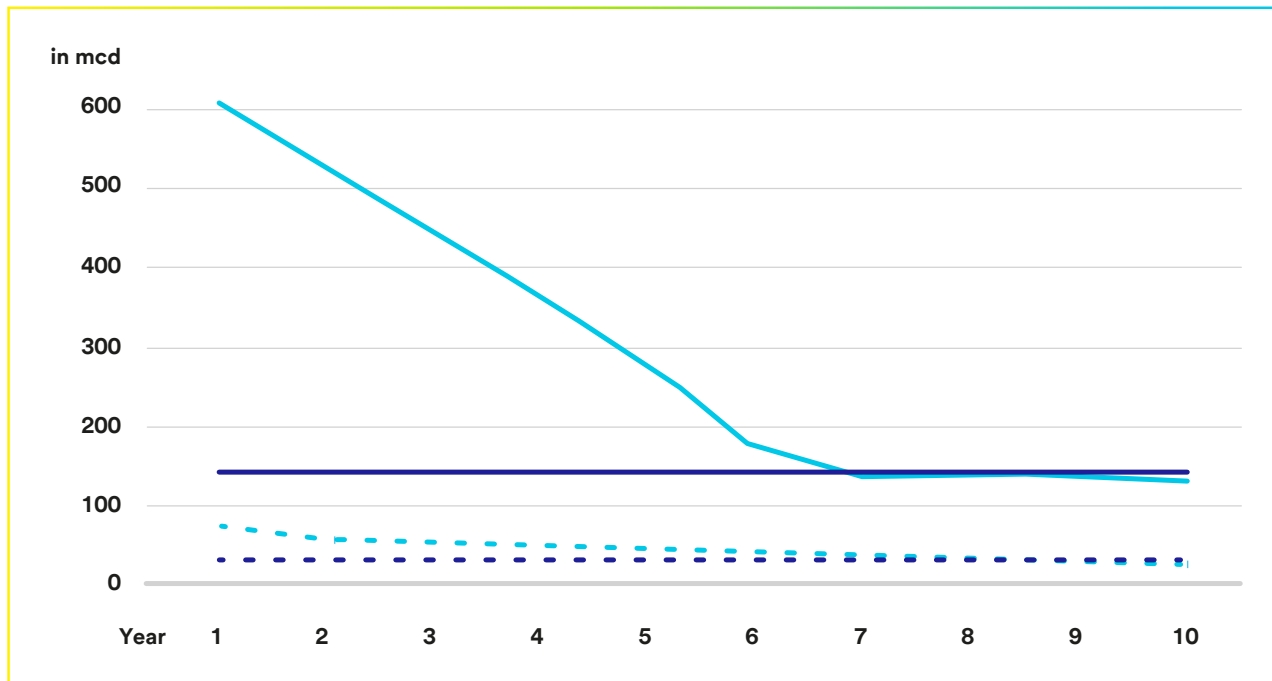
of the population will be over 60 years old by 2050.<sup>4</sup> A motorist in the 60-plus generation needs 8x more brightness than a 20 year old

### Sources :

- 1 Quality measurements 3M Germany, sample from selected motorways throughout Germany, 2002 – 2007
- 2 Variables influencing the nighttime legibility of highway signs – Paul L. Olson, Michael Sivak, James C. Egan – JULY 1983
- 3 IderSafe / Risks and countermeasures for road traffic of elderly in Europe, Final report N° MOVE/C4/2014-244, European Commission, 2015
- 4 UN report world ageing population

# Safety and cost efficiency over the years

Average measurements for retroreflection of 3M™ Stamark™  
High Performance Pavement Marking Tape A380ESD



A plus for safety and durability, with long-term compliance to high safety standards.

3M™ Stamark™ Pavement Marking Tapes offer high performance, proven durability, optimise replacement intervals and save maintenance costs over the entire life of the road surface.

— Night visibility      — Minimum requirements for night R3 class (150 mcd)  
- - - Night/wet roads      - - - Minimum requirements for night/wet roads RW2 (35 mcd)



# Impact of highway construction work zone on fuel consumption and greenhouse gases

Study to analyse pavement/pavement marking life cycles.

- ▶ Traffic interruption by lane closures in Connected Work Zones (CWZs) is unavoidable during road maintenance activities
- ▶ Evaluation of environmental impact by vehicles at various CWZs for highway maintenance and rehabilitation
- ▶ Factorials developed considering traffic volumes, vehicle types, drive cycles, highway categories and work zone traffic operation plans
- ▶ Fuel consumption and greenhouse gases emissions were chosen as the indicators and were estimated using the motor vehicle emission simulator (MOVES)
- ▶ Comparisons were made for heavily congested CWZs versus uncongested traffic without CWZ
- ▶ Mitigating CWZ traffic congestion from heavy to medium congestion would reduce fuel consumption and GHG emissions by 40% on a freeway and 32% on a multilane road

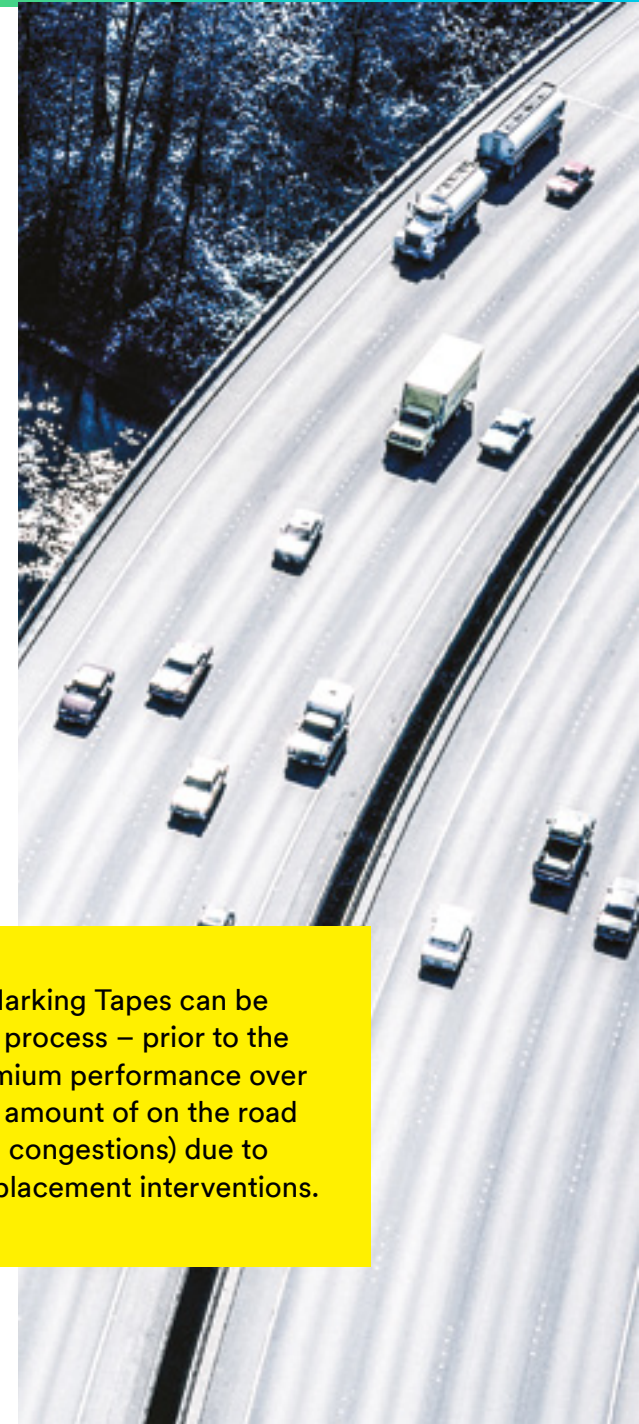
For the freeway scenarios: fuel consumption and GHG emissions increased by **85% and 86%** respectively



For multi-lane road scenarios: increase of **83% and 84%**



3M™ Stamark™ Pavement Marking Tapes can be inlaid during the asphaltting process – prior to the road opening – and its premium performance over its full life time reduces the amount of on the road interventions (and potential congestions) due to repair, maintenance and replacement interventions.



# German noise study

**Methodology: CPX measurements of noise emissions when driving over different types of markings.**

**CPX is a measurement method according to ISO/CD 11819-2, in which the tyre-road noise can be determined without being influenced by the conditions of the measurement environment.**

The measurements were carried out by Müller-BBM GmbH in autumn 2009, one of the leading engineering offices for consulting services, tests and planning for environmental and emission protection.

## Measurement speed



80 km/h  $\pm 1$ km/h

## Road temperature



15–22°C/dry road

## Age of the road markings



2 to 3 years after the application

## Date



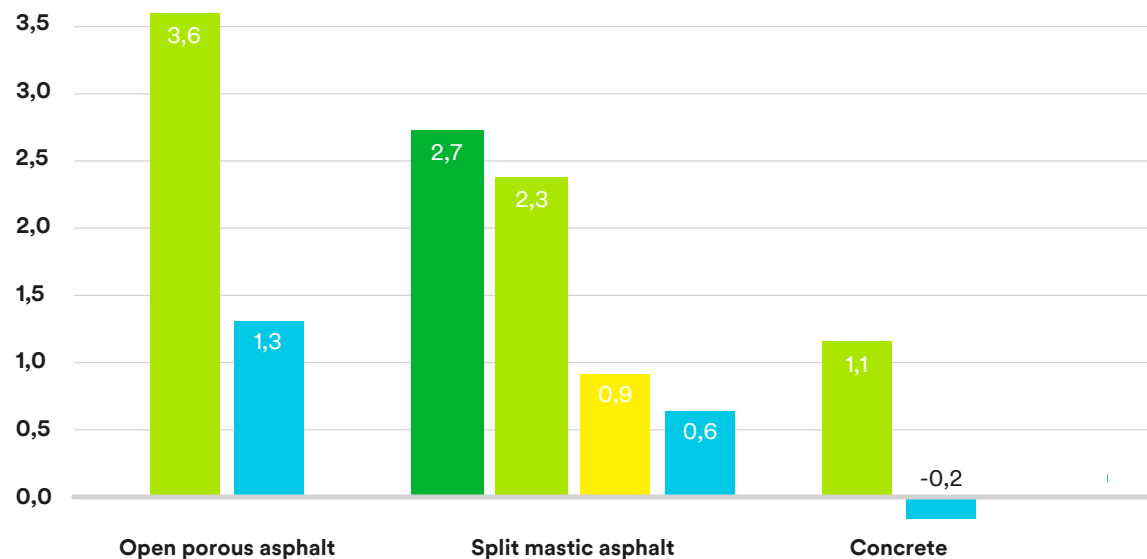
November 2009



# Reduce noise pollution on roads

Comparison of the additional noise pollution created when driving over different marking systems on different road surfaces.

Additional noise emissions by markings,  $\Delta$  dB (A)



**Tape marking causes virtually no additional noise.**

- Agglomerate stochastic
- Profiled tape 3M™ Stamark™ A380 ESD marking tape
- Agglomerate 'Visidots'
- Cold spray plastic

$\Delta$  3.0 dB (A):  
Perception corresponds  
to a doubling of the ADT\*

$\Delta$  1.0 dB (A):  
Corresponds to the  
perception threshold

\*average daily traffic volume



# Camera readability

**Vedecom 3M Study: road markings and camera detection.**

**Performance of ADAS Lane keeping system is influenced by contrast between marking and road surface.**

## Objective

Study by Vedecom looked at contrast of various markings on asphalt at 15m in front of the car.

Note that data collection was done at 12km/h and with enhanced detection/identification methods not used in commercial ADAS today (data fusion with LiDAR image, GPS tagging of the marking samples, improved algorithm).

Even with an improved detection system, for adverse weather conditions some of the above markings went as low as 19% of the expected data input. Only 3M™ Stamark™ Pavement Marking Tape A380AW remained close to a 90% detection rate (data confidence).



# Camera readability

## Vedecom 3M Study: road markings and camera detection.

### Conclusions

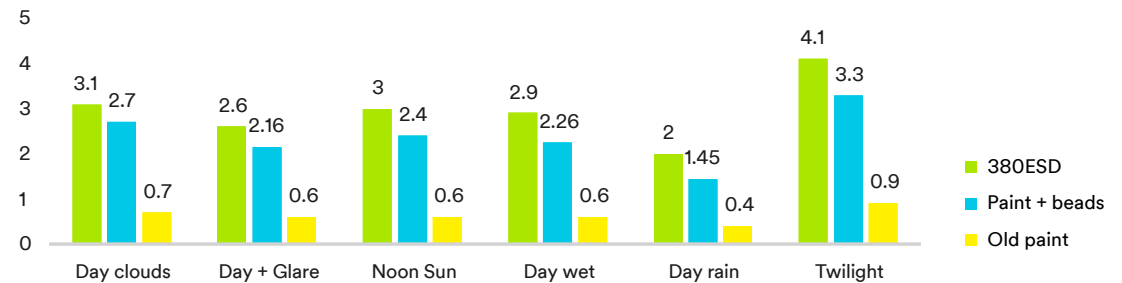
- **Daytime contrast** is improved by **whiteness** of the marking (Qd). The effect of rain with or without glare will reduce contrast, so reduce reliability of the ADAS lane keeping system.

Due to the darkness of the road it is easier to create good contrast at night.

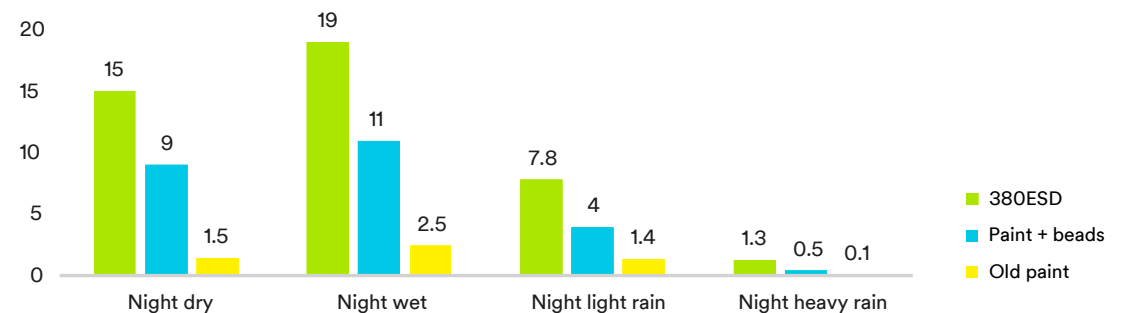
- **Night time contrast** is improved by better retroreflective properties of the markings. This is solely depending on the quality of the beads. Standard beads (RI 1,5 to 1,9) may not reflect sufficient light back to the car when wet. Only beads with RI 2,4 can keep the marking visible during various rain conditions. Stamark A380AW contains both RI 1,9 and RI 2,4 beads.

Note that earlier studies indicate a positive impact of diffuse illumination (Qd) till 20m look ahead distance.

### Contrast during daytime



### Contrast during nighttime





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