

Temporary Tape - High Reflectivity for Changed Road Configurations

Presentation to NZRF/RIAA/RSMA Conference by Michael Holderness



Visibility
and Safety for the
Life of the Road



Changed Road Configurations

- What happens when you put in a Temporary Work Zone and move the road markings?
 - *You create a hazard requiring greater visual attention*
 - *You need the road user to be able to find their way through an unfamiliar setting*
 - *Often the old markings are still visible so you need to hide them*
- You actually need brighter markings to stand out from the surroundings to get the attention of the driver

Worst Case Driving Conditions?

NIGHT TIME



RAIN



CONSTRUCTION WORK ZONE

“...drivers are three times as likely to be involved in an accident during rainy or wet pavement conditions...”



Human Factor Considerations

During Adverse Weather Conditions

- Reduced Visibility
 - *Light transmission through the rain*
 - *Rain hitting the windscreen*
 - *Glare from oncoming cars*
 - *Movement and condition of the wipers*
 - *Road spray*
 - *Steamed windscreen*
 - *Headlight misalignment*
 - *And more*

Crash Fatalities During Rain Conditions

49%	<i>Daytime</i>
47%	<i>Nighttime</i>
4%	<i>Dawn/Dusk</i>

New Zealand Data

- 34% of Serious and Fatal Accidents Occur at night
- This does not take into account the low volume of vehicles travelling at night.
- If we estimate vehicle volume a 80/20 split Day/Night this makes travelling at night even more hazardous

Source – NZTA CAS Database 2013



Construction Work Zones can be a Hazardous Place

- They often require quick decisions by the motorist due to
 - *Lane closures*
 - *Rerouted traffic*
 - *Confusion*
 - *High speeds*
- About 50% of work zone fatalities occur during the hours of darkness



Global Trends in Developed Countries

- Increasing number of work zones
- Increasing night work
 - *Particularly in high speed areas like Motorways*
 - *The volume of traffic during daylight hours precludes day work*



The Ideal Construction Work Zone



**Provide guidance for the motorist 24/7
in all weather conditions**

Pavement Markings Can Help to Clearly Delineate the Path In The Construction Work Zone

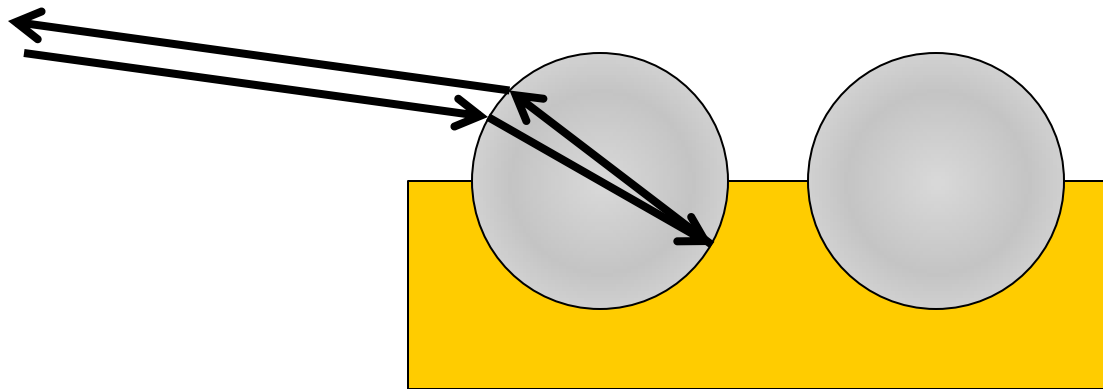


New Data

- Paul Carlson – Texas A&M Transportation Institute
 - *Analysed Michigan DOT data for road reflectivity and compared that with accident data for the same roads*
 - *Report released July 2012*
 - *“The Evidence Is Pretty Compelling” “Brighter Markings Mean Safer Roadways”*

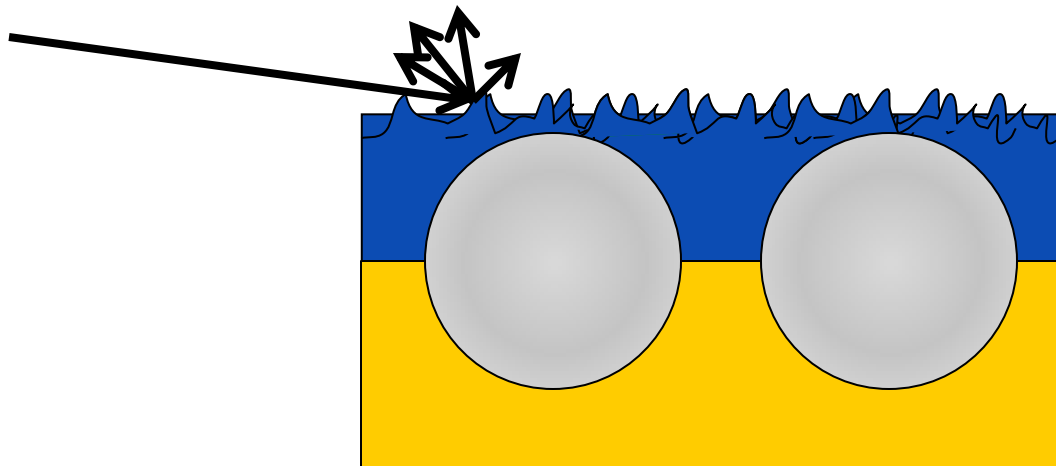
Retroreflectivity

- In Dry Conditions . . .
- Light enters the glass bead
- And is returned to the driver



Retroreflectivity

- In Wet Conditions with Standard Glass Beads . . .
- Most of the light hits the water surface
- and undergoes specular reflection
- A small amount of light can penetrate to the beads but is inefficiently scattered and is not reflected back to the driver



Wet Reflectivity versus Wet Recovery

- There is a lot of talk in the industry about wet reflectivity however there can be some confusion in terminology with this statement
- There are two issues
 - *Wet Reflectivity*
 - *Where the glass bead can still perform even when covered by a layer of water*
 - *Wet Recovery*
 - *Where the glass bead cannot perform underwater but recovers its reflectivity quickly once the water drains off*



Wet Retroreflectivity

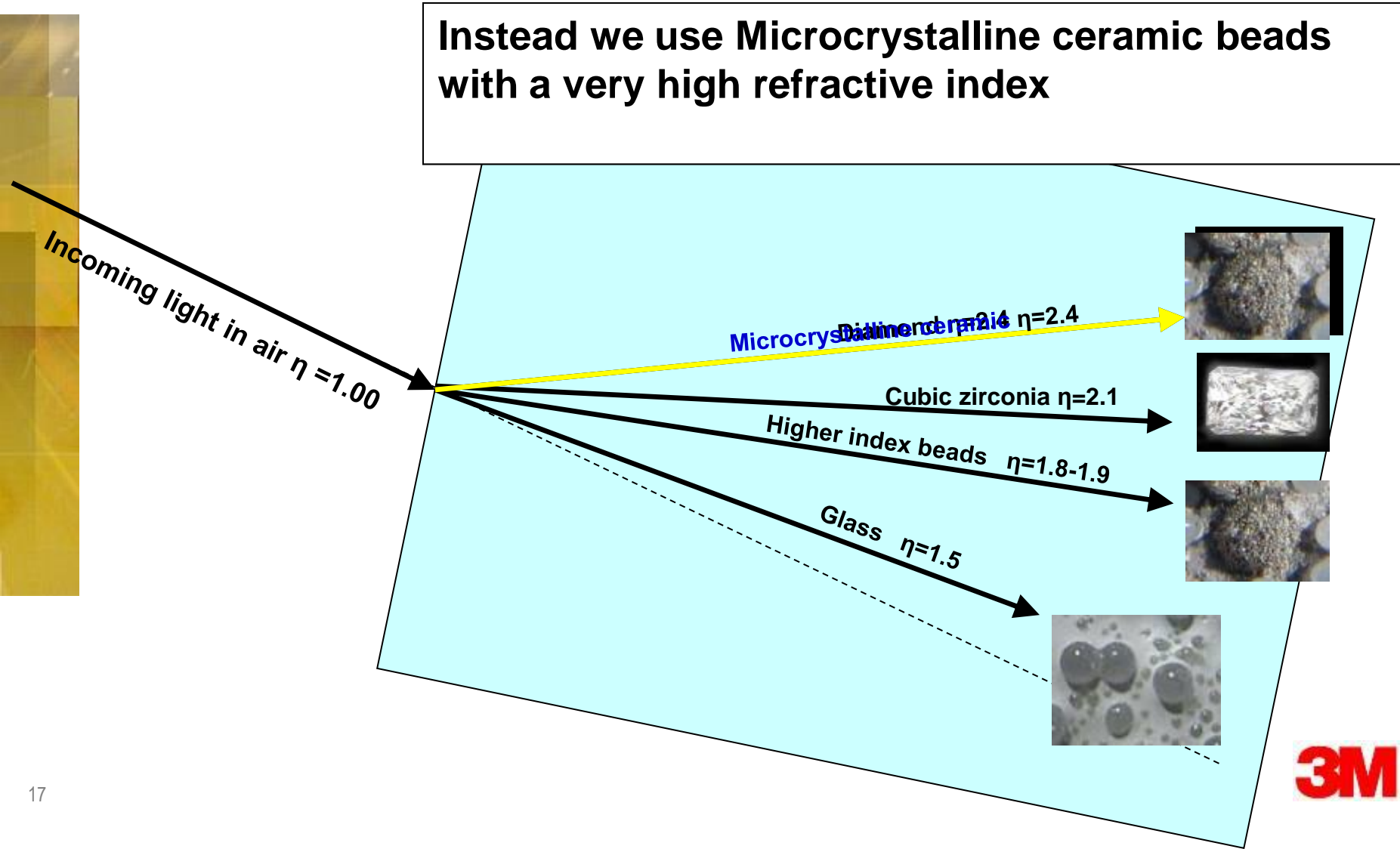


- To get road markings to reflect light in wet conditions we need more than one type of glass bead
- Dry reflective glass beads ($\eta=1.5$)
- Dry reflective elements ($\eta=1.9$) provide maximum reflectivity under dry conditions
- Wet reflective elements ($\eta=2.4$) incorporate water into the optics, providing maximum reflectivity when wet.
- They work together to provide higher levels of performance in all weather conditions



Refractive Index is a measure of the degree of bending

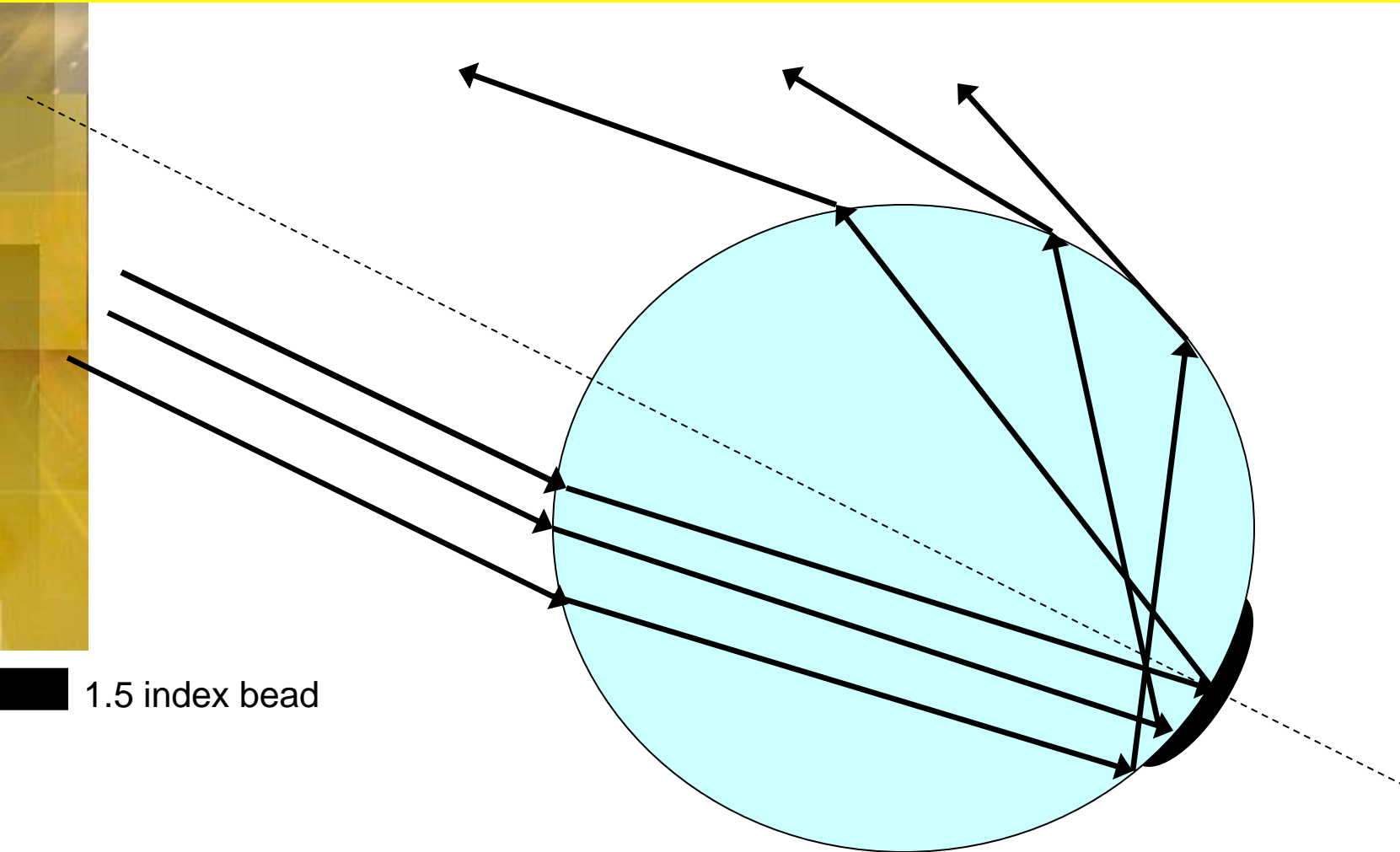
Instead we use Microcrystalline ceramic beads with a very high refractive index



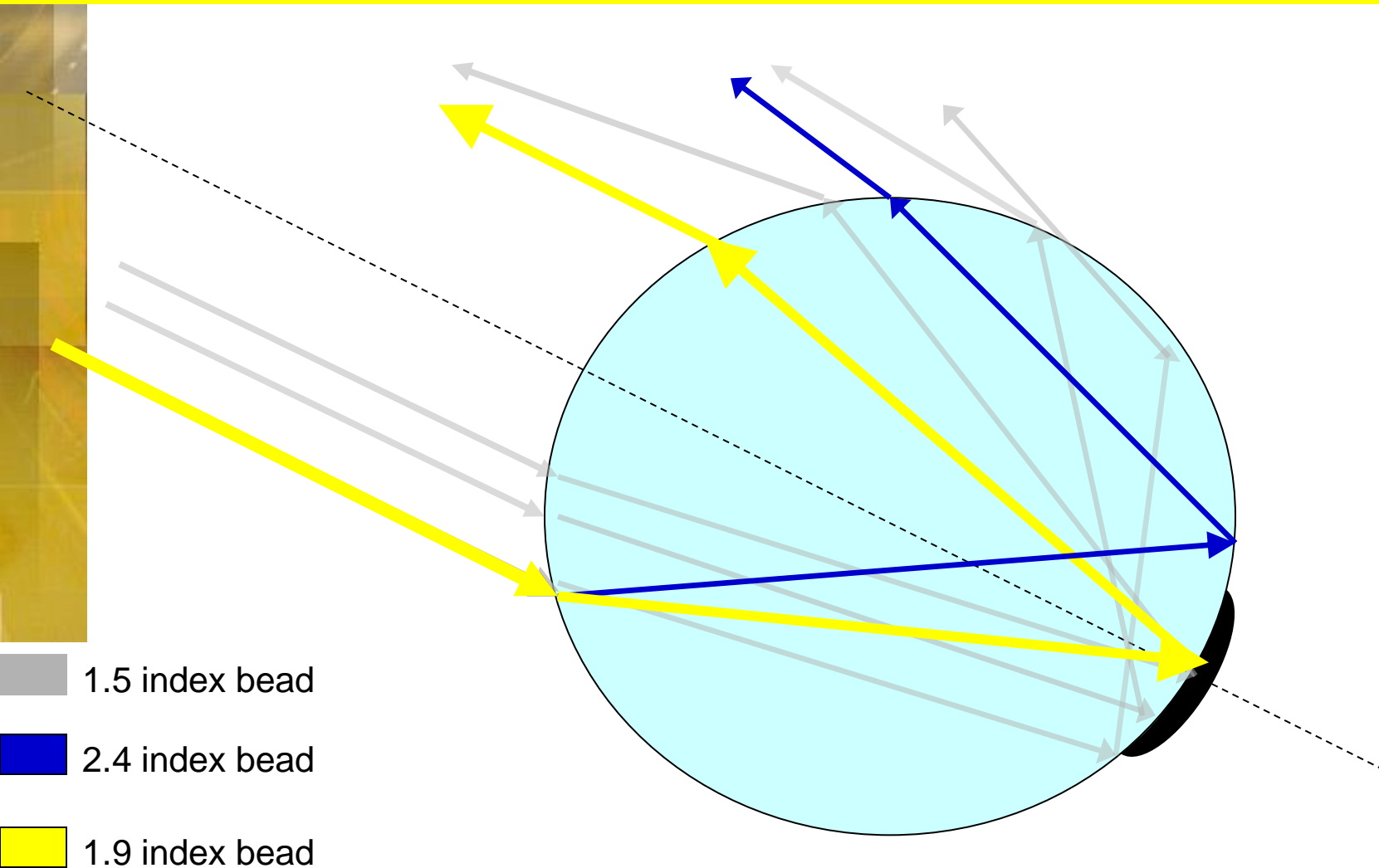
How does refractive index relate to pavement markings?



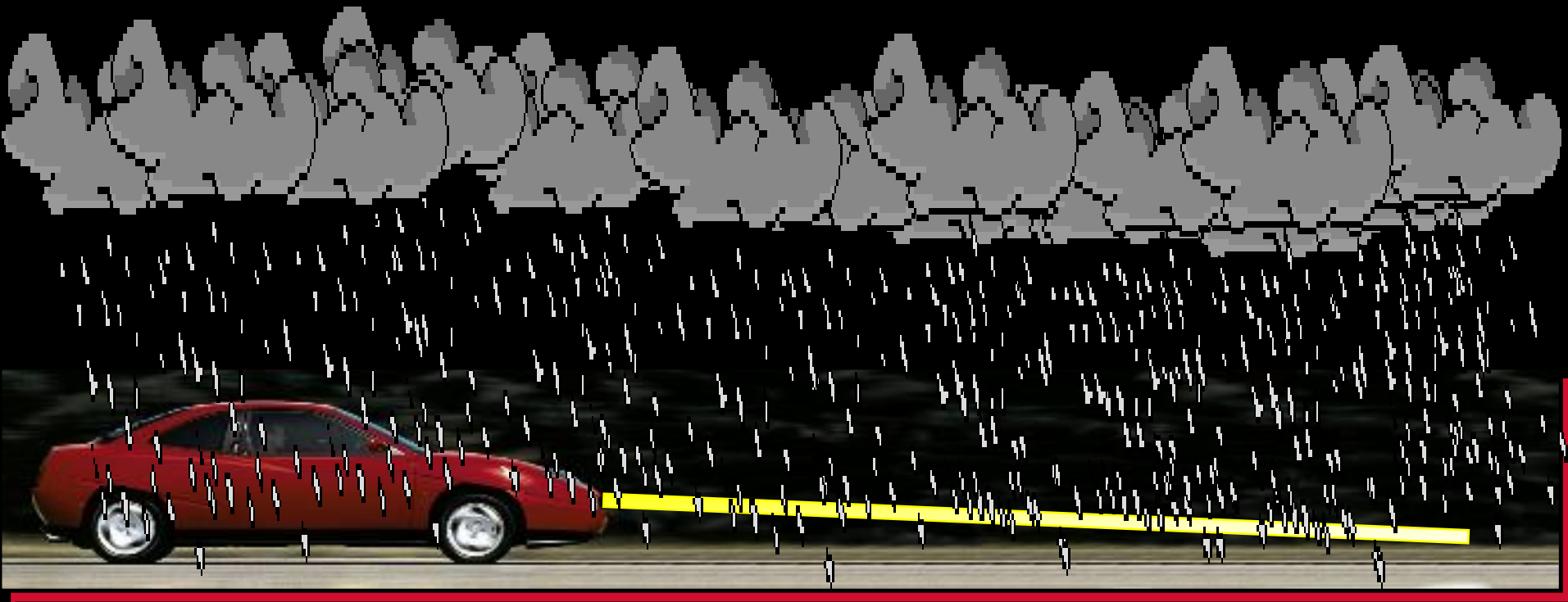
But pigment is needed for retroreflection.



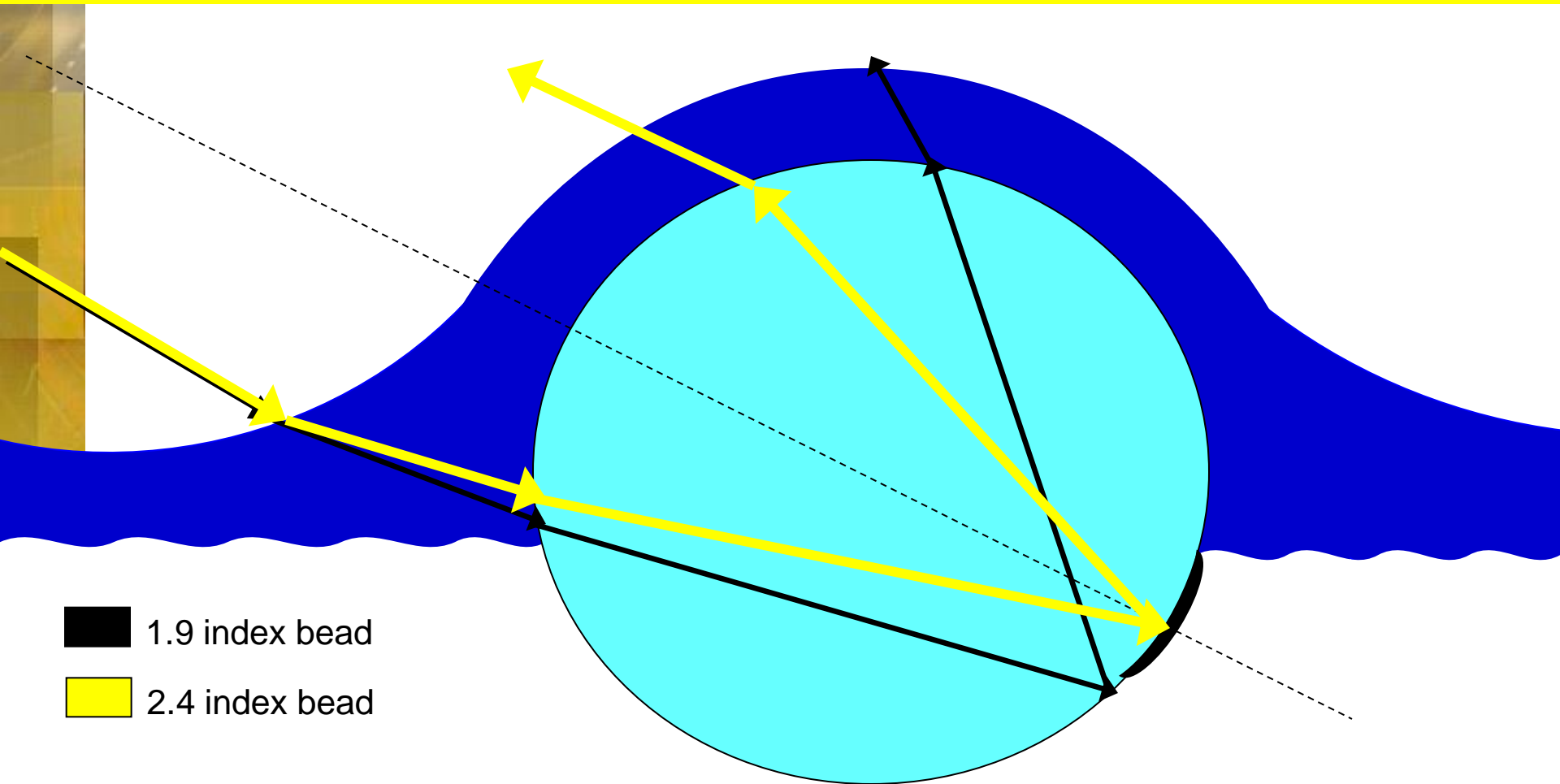
The 1.9 index bead best directs the light in dry conditions



**But what happens when we add
water?**



The 2.4 index bead best directs the light in wet conditions.

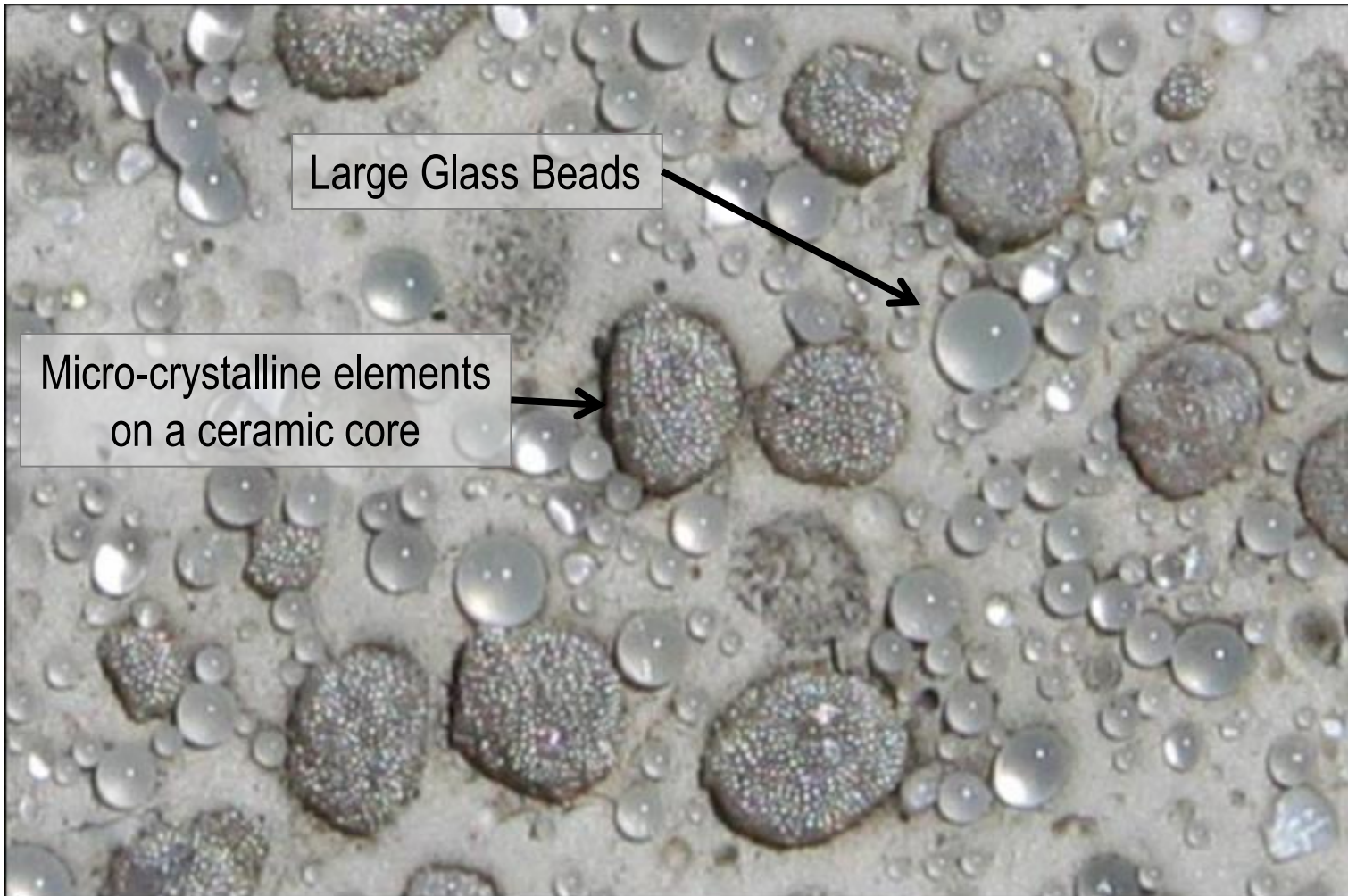


- 1.9 index bead
- 2.4 index bead

Dry and Wet Reflective Markings

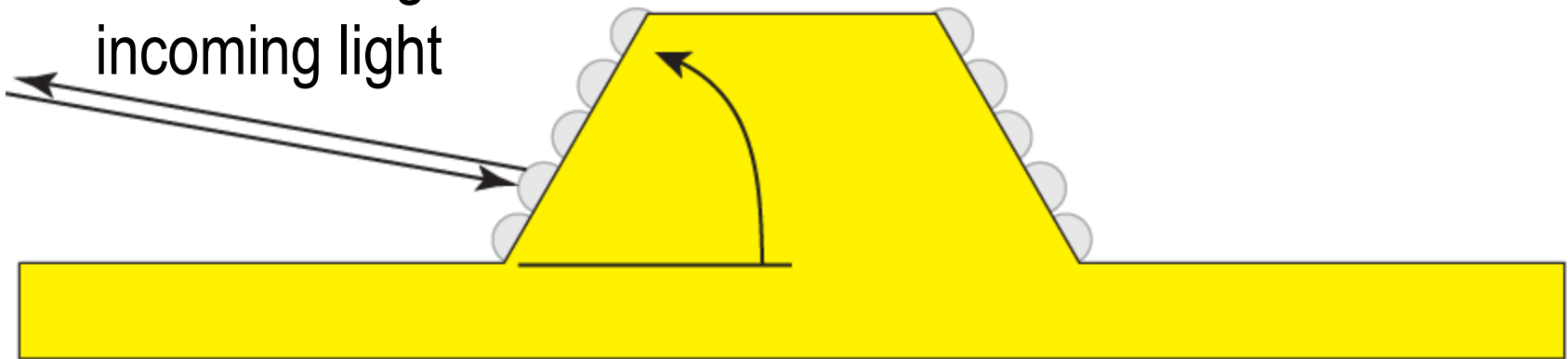
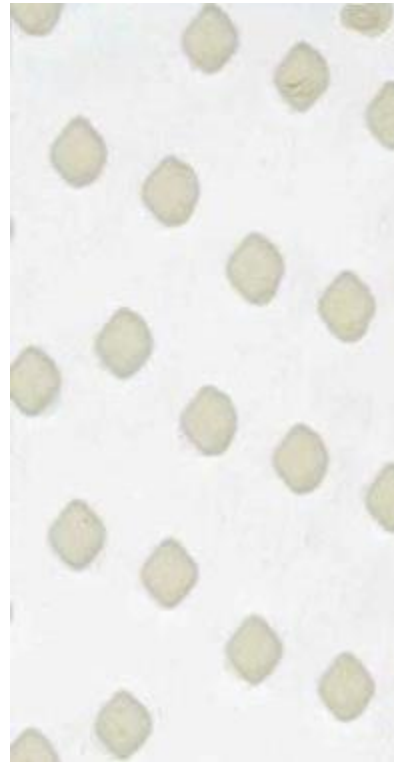
- The most effective marking will have
 - *Both dry and wet elements (1.9 and 2.4 index beads)*
 - *A method of raising the elements above the waterline to improve Wet Recovery performance*
 - *Large Glass Beads*
 - *Profiled Marking*

Large Glass Beads or Micro-crystalline Elements



Profiled Marking

- By rotating the reflective surface up, the elements are raised above the water
- This also helps improve reflectivity by altering the entrance angle of the incoming light



Reflectivity

- NZTA P30 Specification High Performance Roadmarking
 - *Dry 150 mCd/Lx/m²*
 - *Wet 80 mCd/Lx/m²*
- 3M Stamark Wet Reflective Removable Tape Series 710
 - *Dry 500 mCd/Lx/m²*
 - *Wet 250 mCd/Lx/m²*

At 30m Geometry - 88.76° Entrance Angle and 1.05° Observation Angle

So What?

- The Ideal Construction Work Zone will provide guidance for the motorist 24/7 in all weather conditions
- Best Practice
 - *High Reflectivity*
 - *Day and Night Visibility*
 - *Wet and Dry Performance*
- This means using a high visibility marking in all conditions

References

- NZTA CAS Database (2013)
- NZTA P30 2009 Specification (2009)
- US FARS Database (2001)
- Development of Human Factors Guidelines
FHWA-RD-99-130 December, 1999, Page 6
- Brodsky & Hakkert (1988) Accident Analysis and
Prevention, 20(3) 161-176
- The Benefits Of Using Temporary Linemarking At Road
Work Sites – Doris Stroh, AMA, NZTA

3M