

# 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

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

Data Source: FARS Database 2001 – US Data

# 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

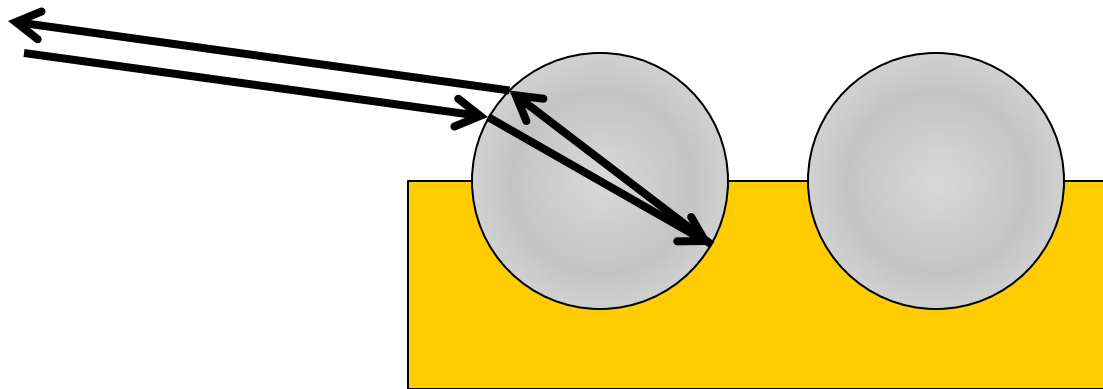


# New Data

- 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”*

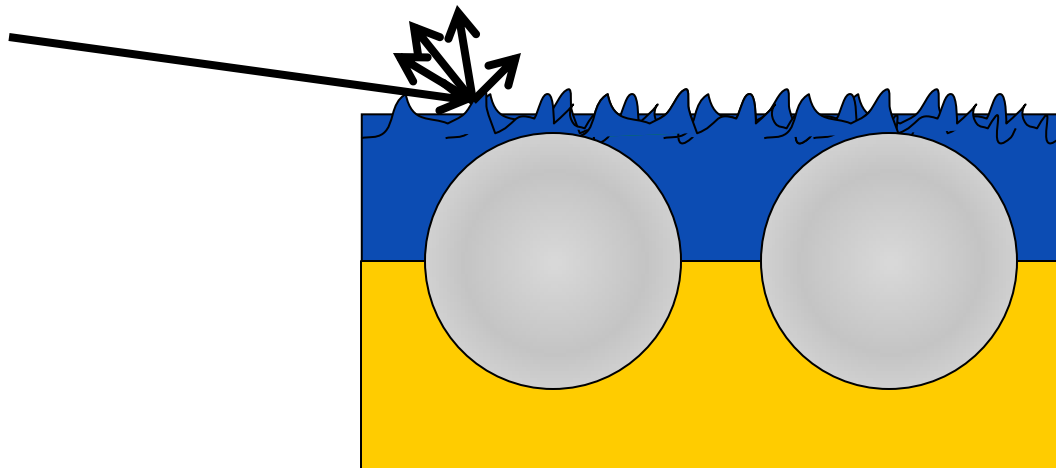
# Retroreflectivity

- 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*



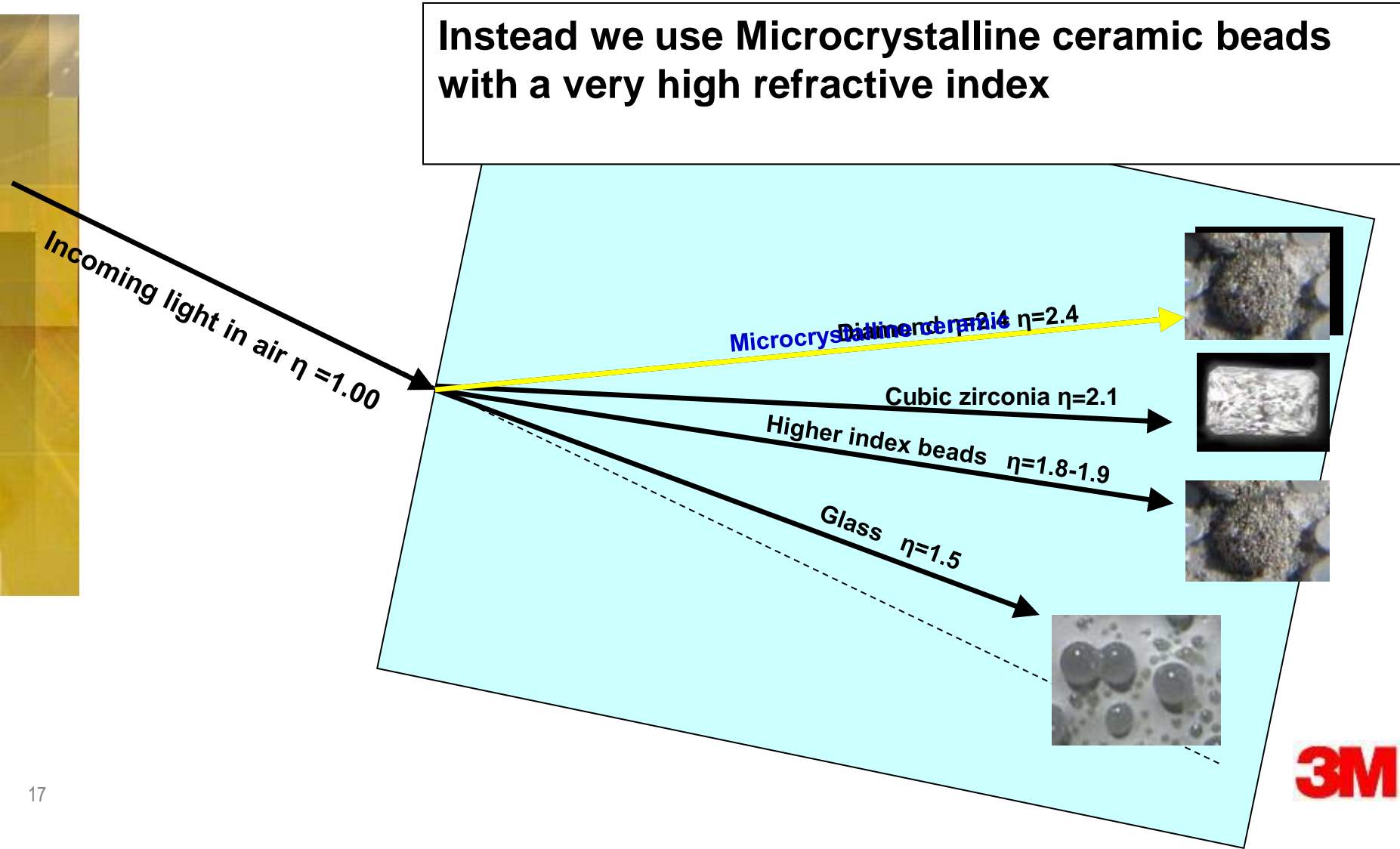
# Wet Retroreflectivity



- 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

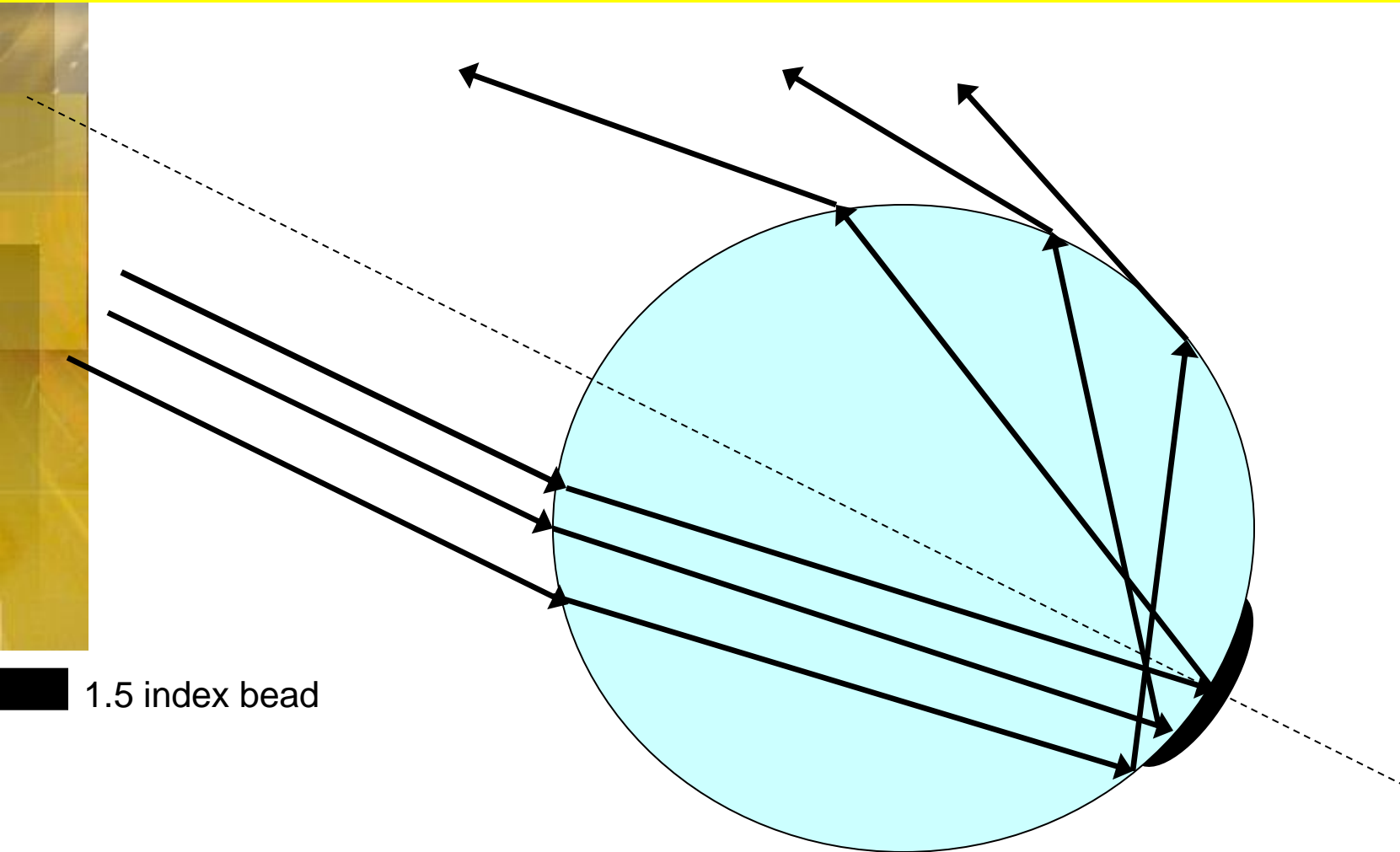
Instead we use Microcrystalline ceramic beads with a very high refractive index



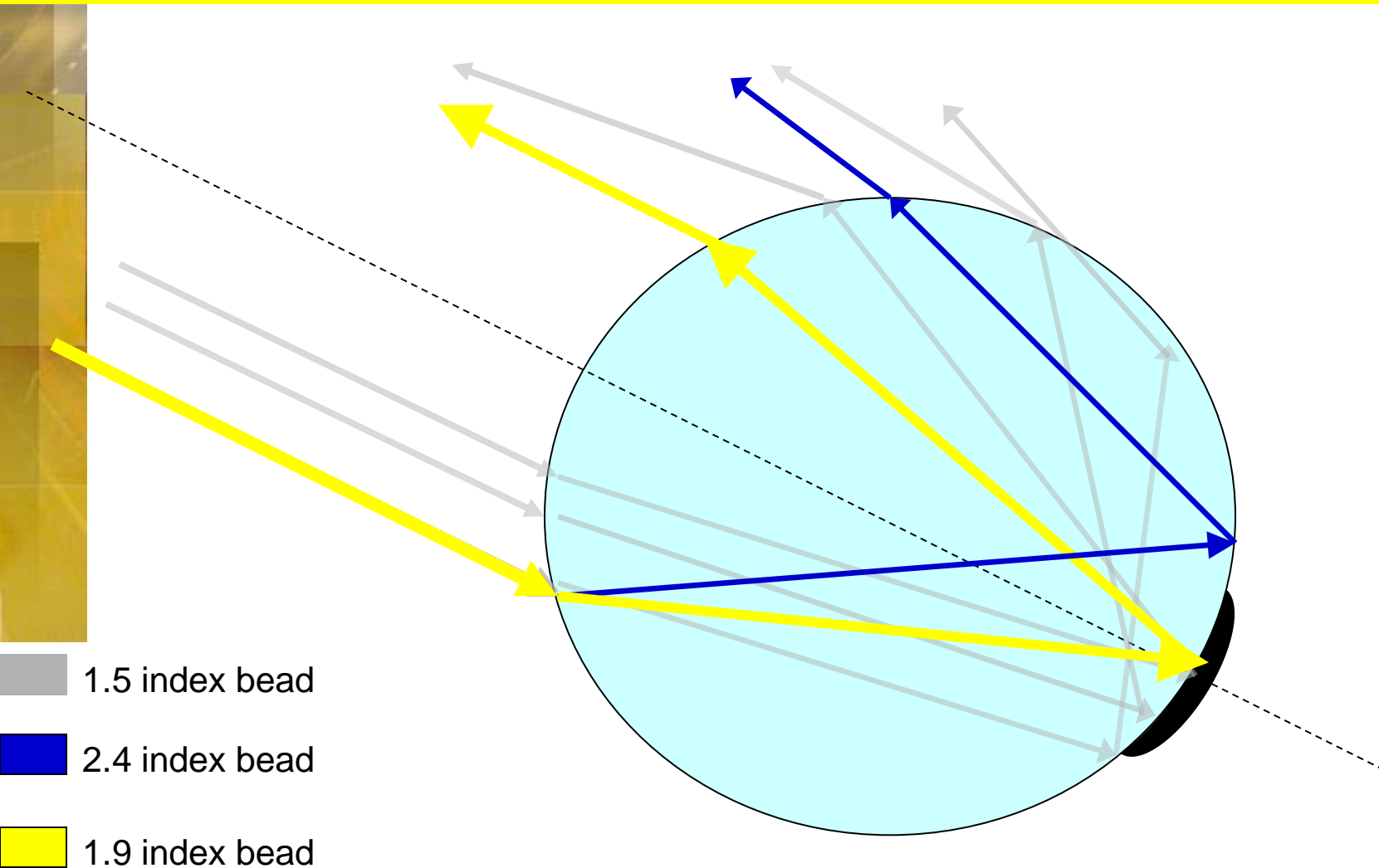
# How does refractive index relate to pavement markings?



**But pigment is needed for retroreflection.**

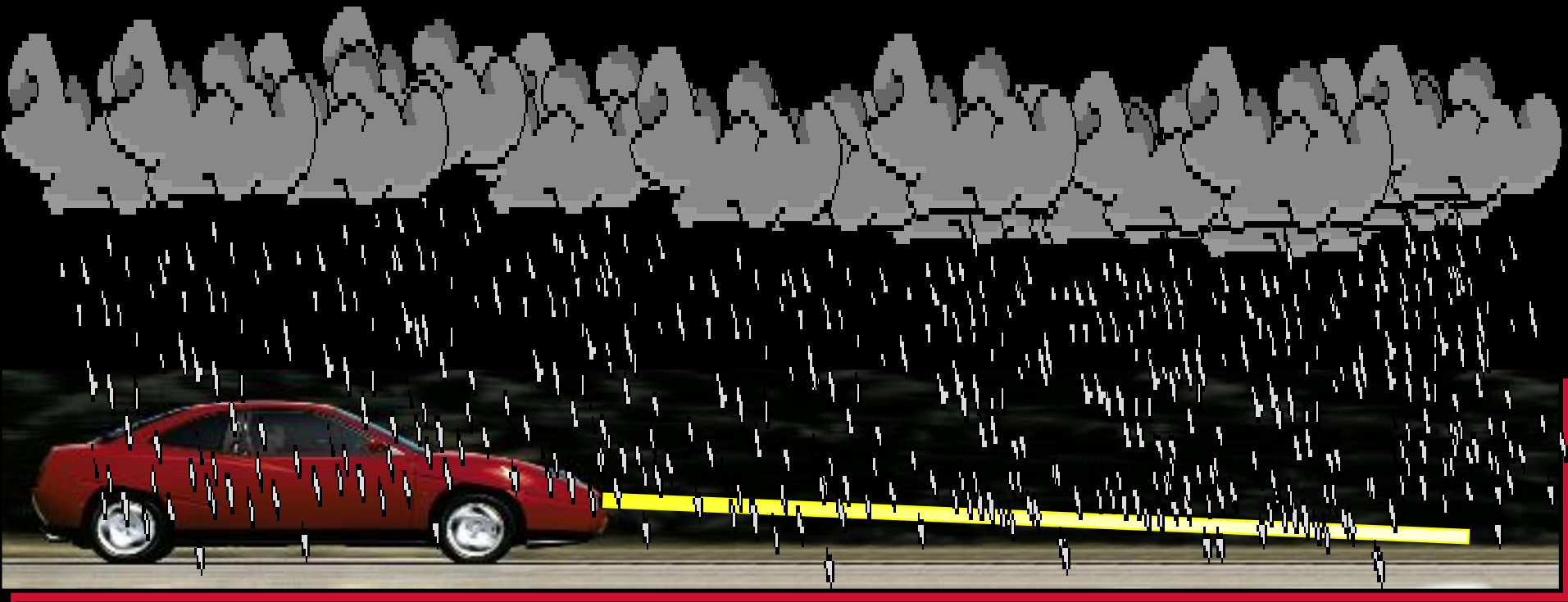


## The 1.9 index bead best directs the light in dry conditions

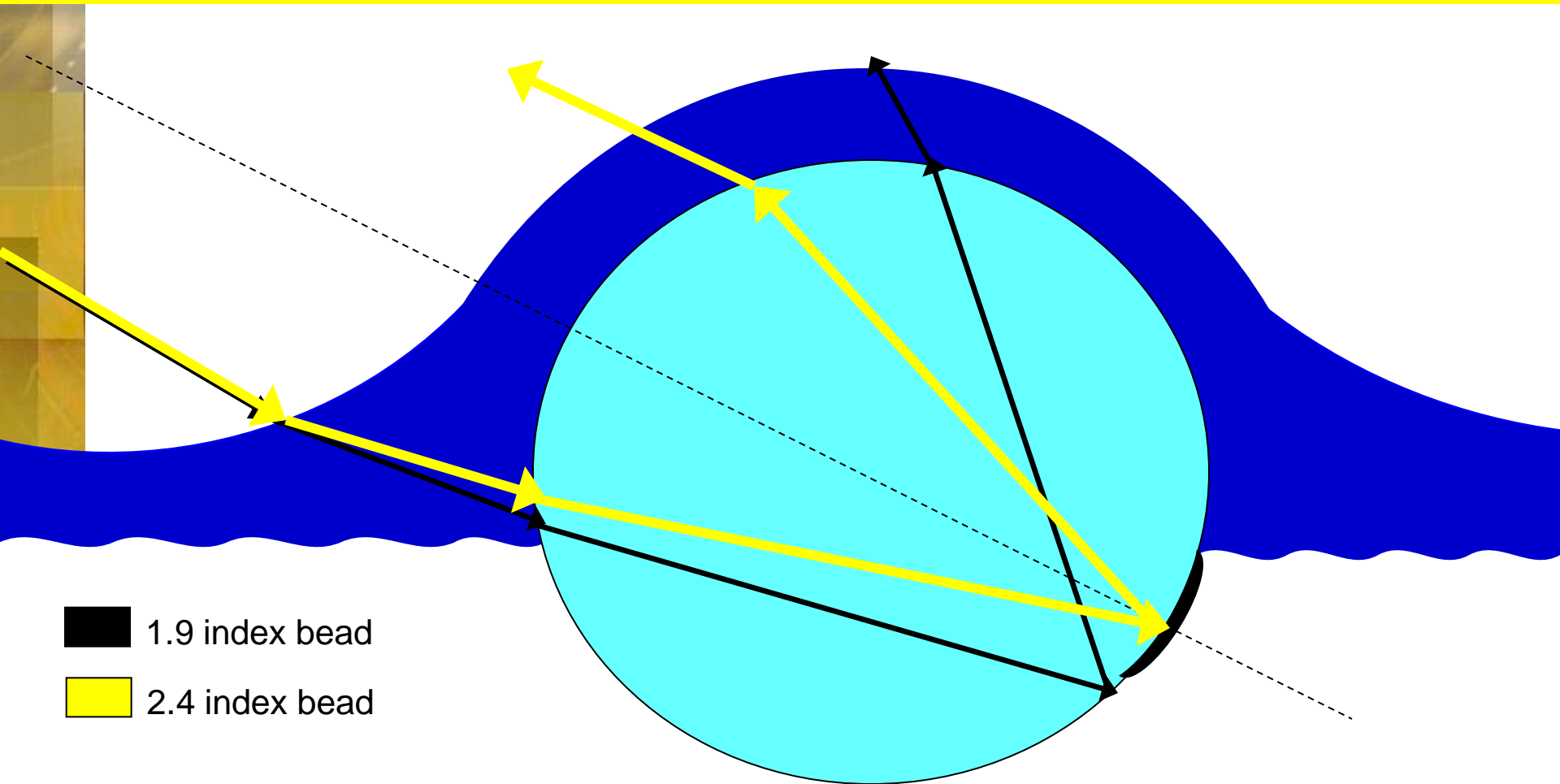




**But what happens when we add  
water?**



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

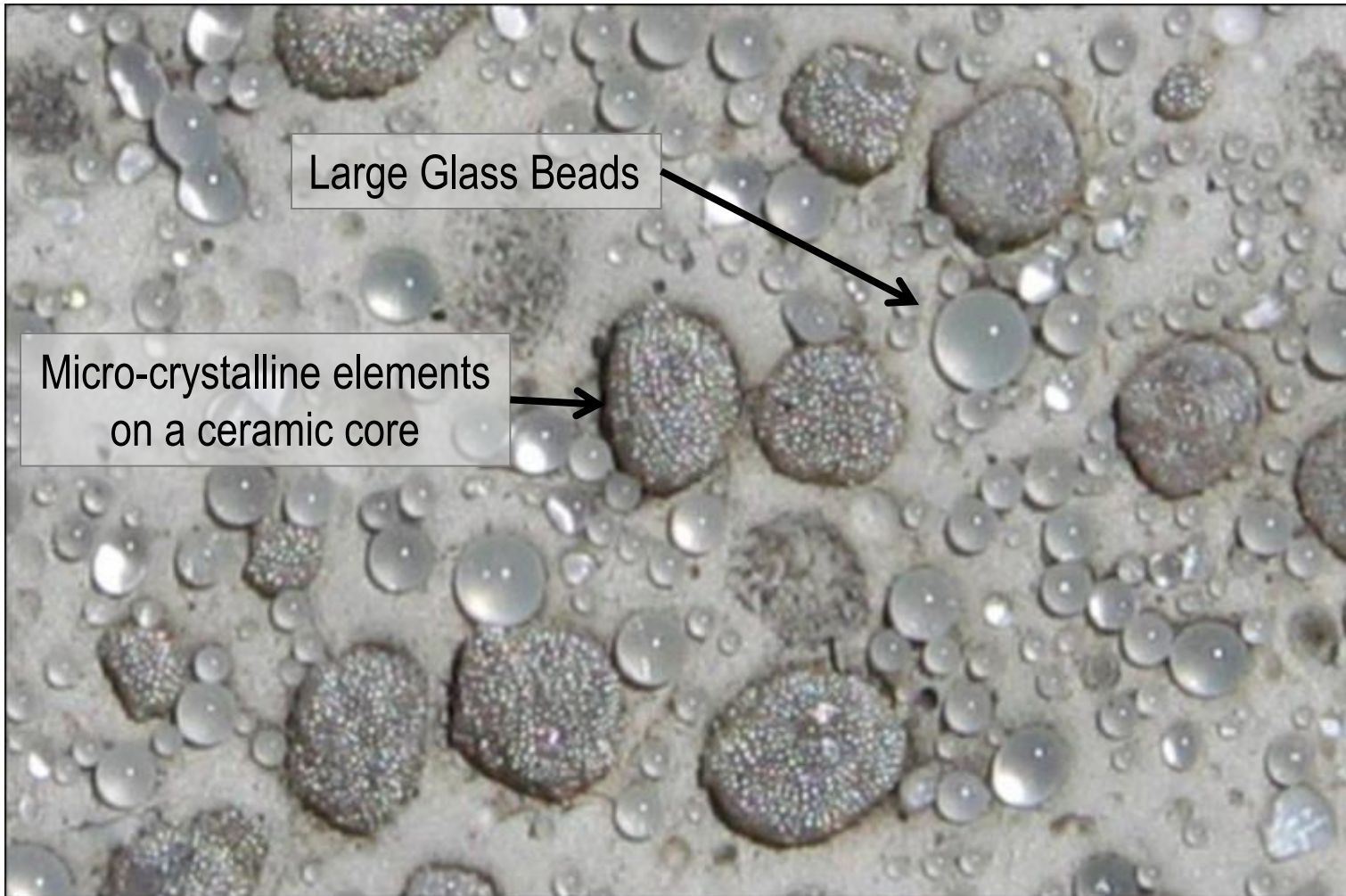


- 1.9 index bead
- 2.4 index bead

# Dry and Wet Reflective Markings

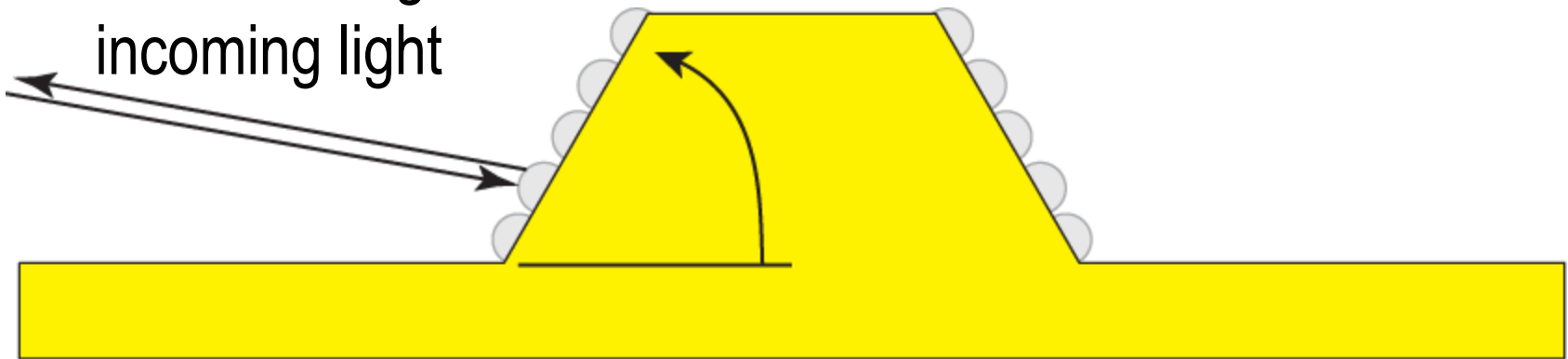
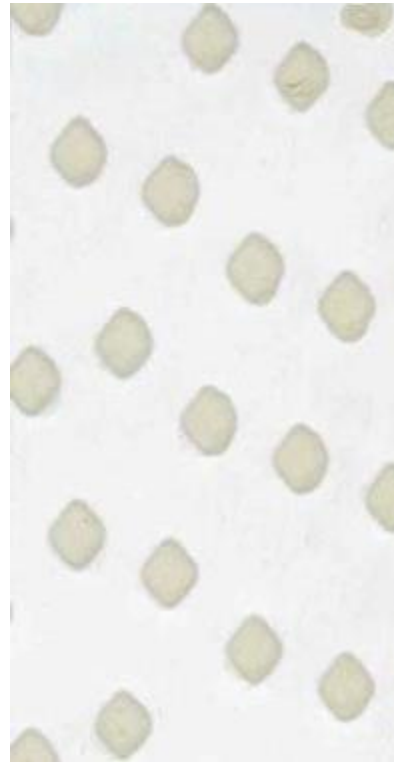
- The most effective marking will have
  - *Both dry and wet elements (1.9 and 2.4 index beads)*
  - *A method of raising the elements above the waterline to improve Wet Recovery performance*
    - *Large Glass Beads*
    - *Profiled Marking*

# 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/m<sup>2</sup>*
  - *Wet 80 mCd/Lx/m<sup>2</sup>*
- 3M Stamark Wet Reflective Removable Tape Series 710
  - *Dry 500 mCd/Lx/m<sup>2</sup>*
  - *Wet 250 mCd/Lx/m<sup>2</sup>*

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**