

Lecture 3.25

3.5 Road Markings

Detailed IRC:35 Marking Layout at Signalized Intersections

Signalized intersections require a complete integrated package of transverse and longitudinal pavement markings to guide vehicles into proper lanes and keep clearance boxes open.

Improper intersection marking allows vehicles to block cross-traffic, leading to total junction gridlock.

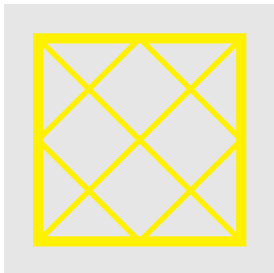
- Transverse Stop Line: 200mm to 300mm solid white line positioned 2m to 3m ahead of crosswalk
- Pedestrian Crosswalk: Zebra stripes (500mm width) or two parallel transverse dashed lines
- Lane Assignment Arrows: Painted 15m, 30m, and 45m in advance of stop line
- Continuity Lines: 100mm broken white lines extending turning lanes through wide junction boxes

Yellow Box Junction Markings ('Keep Clear' Zones)

Yellow box junction markings consist of criss-cross yellow diagonal lines painted within the central intersection area.

They enforce the strict legal rule that drivers must not enter the grid box unless their exit lane is completely clear, preventing gridlock during heavy traffic.

- Pattern: Perimeter solid yellow line enclosing diagonal yellow criss-cross hatchings
- Legal Directive: Strictly prohibits stopping or queueing inside the painted box zone



Markings at Priority Intersections and Roundabouts

Unsignalized priority junctions and rotary roundabouts rely heavily on pavement markings to assign right-of-way without electric signals.

Markings indicate yielding obligations and channelize entering traffic into smooth tangential paths.

- Give Way Lines: Two transverse broken lines across minor street, preceded by Give Way triangle
- Yield Triangle Legend: Inverted triangle painted on pavement 10m to 20m before yield line
- Roundabout Entry Line: Broken white yield line along circulatory entry curve
- Deflection Markings: Curved channelizing lines directing entering vehicles to yield to right

Expressway and Multi-Lane Highway Markings

High-speed multi-lane expressways require wider marking dimensions and specialized hazard delineation to maintain vehicle guidance at speeds above 100 km/h.

Thicker line dimensions and retroreflective studs are mandatory on expressways.

- Carriageway Edge Lines: Continuous solid white line (width 150mm) along outer shoulder
- Median Edge Lines: Continuous solid yellow line (width 150mm) along central median divider
- Lane Lines: 150mm wide broken white line (segment length 3m, gap length 6m)
- Chevron Markings: V-shaped diagonal hatchings painted on gore areas at exit/entry ramps

Raised Pavement Markers (RPMs) and Cat's Eyes

Raised Pavement Markers (RPMs) or 'Cat's Eyes' are retroreflective studs anchored into the pavement surface to supplement painted line markings.

They provide superior night visibility under heavy rainfall when flat painted lines are submerged under water films.

- Prismatic Corner-Cube Lens: Reflects headlight rays back with high intensity
- Audible Tactical Warning: Provides tactile/vibrational warning when tires cross RPM studs

RPM Color	Installation Location
White	Along lane lines separating same-direction traffic
Red	Along left pavement edge line (shoulder boundary)
Yellow	Along right pavement edge line (central median)

Solar Powered LED Studs and Active Delineation

On dark, unlit rural highway curves, passive retroreflective studs depend entirely on vehicle headlights. Active solar-powered LED road studs provide self-luminous guidance.

Solar studs store energy via top-mounted photovoltaic solar cells during daytime and flash high-brightness LEDs continuously throughout the night.

- Active Visibility: Visible from distances exceeding 800 meters (5x distance of passive RPMs)
- Solar Power Matrix: Built-in Ni-MH rechargeable battery and solar micro-panel
- Flash Frequency: Constant light or flashing at 1 Hz to 2 Hz on sharp dangerous curves
- Compressive Strength: Must withstand 20 to 30 ton wheel loads from heavy commercial trucks

Hot-Applied Thermoplastic Material Specifications (IRC:35)

IRC:35 mandates strict physical and chemical properties for hot-applied thermoplastic road marking materials.

The compound is melted on-site in specialized pre-heaters at 180°C to 200°C before application through screed shoes or extruders.

- Binder Content: Synthetic hydrocarbon resin (minimum 18% to 22% by weight)
- Pigment Content: Titanium Dioxide TiO_2 (min 10% for white); Lead Chromate (for yellow)
- Glass Bead Content: Minimum 30% by weight premixed within thermoplastic batch
- Softening Point: Ring & Ball softening temperature must exceed 102°C to prevent bleeding

Drop-On Glass Beads and Application Quality Control

In addition to premixed glass beads, transparent glass spheres are simultaneously pressure-sprayed onto the molten thermoplastic line surface ('drop-on' beads).

Proper bead distribution and embedment depth (50% to 60% sphere diameter) are critical for immediate night retroreflectivity.

- Application Rate: Drop-on glass beads applied at minimum 250 g/m^2 to 350 g/m^2
- Embedment Depth: Ideal 55% embedment; under-embedment causes bead loss; over-embedment reduces reflection
- Gradation (Type 2 / Type 3): Spherical smoothness $\geq 80\%$, particle size 150 to 850 microns
- Quality Tests: Skid Resistance Value ($\text{SRV} \geq 45$), thickness check (min 2.5mm)

Retroreflectivity Auditing and Field Measurement

Pavement marking retroreflectivity is measured in millicandelas per square meter per lux ($\text{mcd}/\text{m}^2/\text{lux}$) using portable pavement retroreflectometers.

IRC:35 mandates minimum retroreflectivity levels for new markings and specifies replacement thresholds when markings wear down.

- Standard Geometry: 30-meter geometry (observation angle 1.05° , entrance angle 88.76°)

Condition / Color	Threshold (R_L in $\text{mcd}/\text{m}^2/\text{lux}$)
New White Markings	≥ 250
New Yellow Markings	≥ 175
Maintenance (Re-striping)	< 100

High-Friction Surface Treatment (HFST) and Special Markings

High-Friction Surface Treatment (HFST) applies tough resin binders and calcined bauxite aggregate to pavement surfaces at high-crash horizontal curves and signal approaches.

HFST dramatically increases skid resistance, reducing wet-pavement braking distances by up to 50%.

- Material: Epoxy / polyurethane binder topped with calcined bauxite aggregate ($SRV \geq 70$)
- Application Sites: Sharp highway curves, steep downgrade signal approaches, pedestrian crosswalks
- Coloured Pavement: Green painted pavement for dedicated cycle lanes; Red for bus lanes
- Photo-Luminescent Markings: Glow-in-the-dark paints absorbing sunlight for unlit tunnel guidance

Summary of Road Marking Standards

In this lecture, we thoroughly covered detailed intersection marking layouts, yellow box junction rules, expressway specifications, RPM cat's eye color codes, thermoplastic material tests, and retroreflectivity auditing under IRC:35.

Strict enforcement of pavement marking standards is essential for high-speed corridor safety and urban traffic discipline.

- Signalized Intersections: Integrated package of stop lines (200-300mm), crosswalks, and lane arrows
- Yellow Box Markings: Criss-cross diagonal lines enforcing 'Do Not Block Intersection'
- RPM Cat's Eyes: Red (left edge), Yellow (right/median edge), White (lane line)
- Thermoplastic Material: Hot-applied at 200°C (2.5mm thickness) with 30% premixed + drop-on glass beads
- Retroreflectivity Audit: Initial $R_L \geq 250 \text{ mcd/m}^2/\text{lux}$ (white); re-striping threshold < 100