Safety Management of Road Network Including Construction Sites

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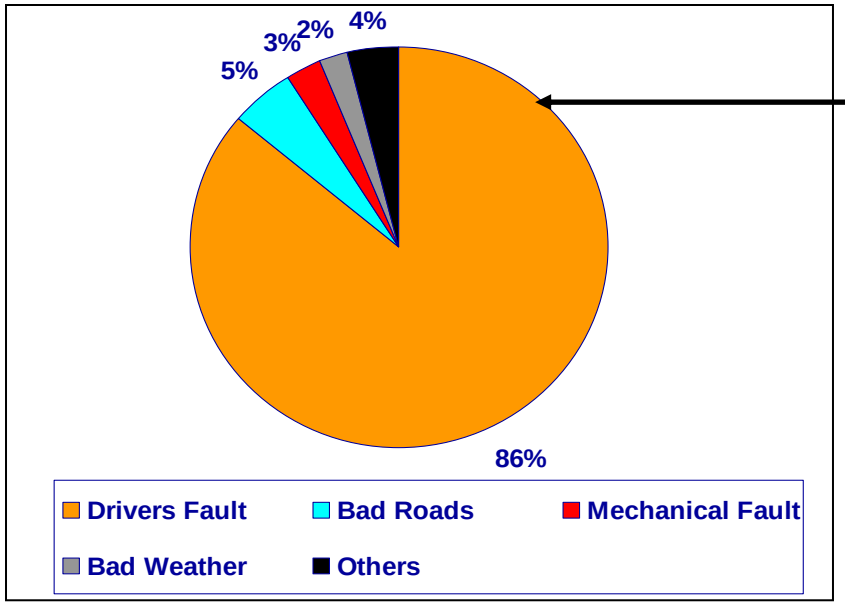
CAUSES OF ROAD ACCIDENTS

- ROAD ENGINEERING
- TRAFFIC ENGINEERING
- LACK OF MONITORING AGENCIES
- HUMAN NEGLIGANCE AND ERROR



Some Commonly Found Faults on Highways

Conclusion?

Engineers need not do anything!!!

Characteristics of Road Accidents

Location	Type of Road User, Percent								
	Truck	Bus	Car	TSR	MTW	HAPV	Bicycle	Pedestrian	Total
Mumbai	2	1	2	4	7	0	6	78	100
Delhi	2	5	3	3	21	3	10	53	100
Highways	14	3	15	-	24	1	11	32	100

Proportion of Road Users Killed at Different Locations in India

Location	Vehicles involved, per cent					Total
	Truck	Bus	Car	TSR	MTW	
Mumbai	52	16	24	3	3	100
Delhi	40	33	16	4	7	100
Highways	65	16	15	1	3	100

Proportion of Vehicles Involved in Fatal Accidents

A Road with Marking

The Same Road without Marking

Safety Management in Road Construction Sites

- ***Topics***
  - Maintenance and Safety
  - Traffic Management
  - Enforcement of Traffic Laws
  - Safety Practices During Road Works

Construction Sites

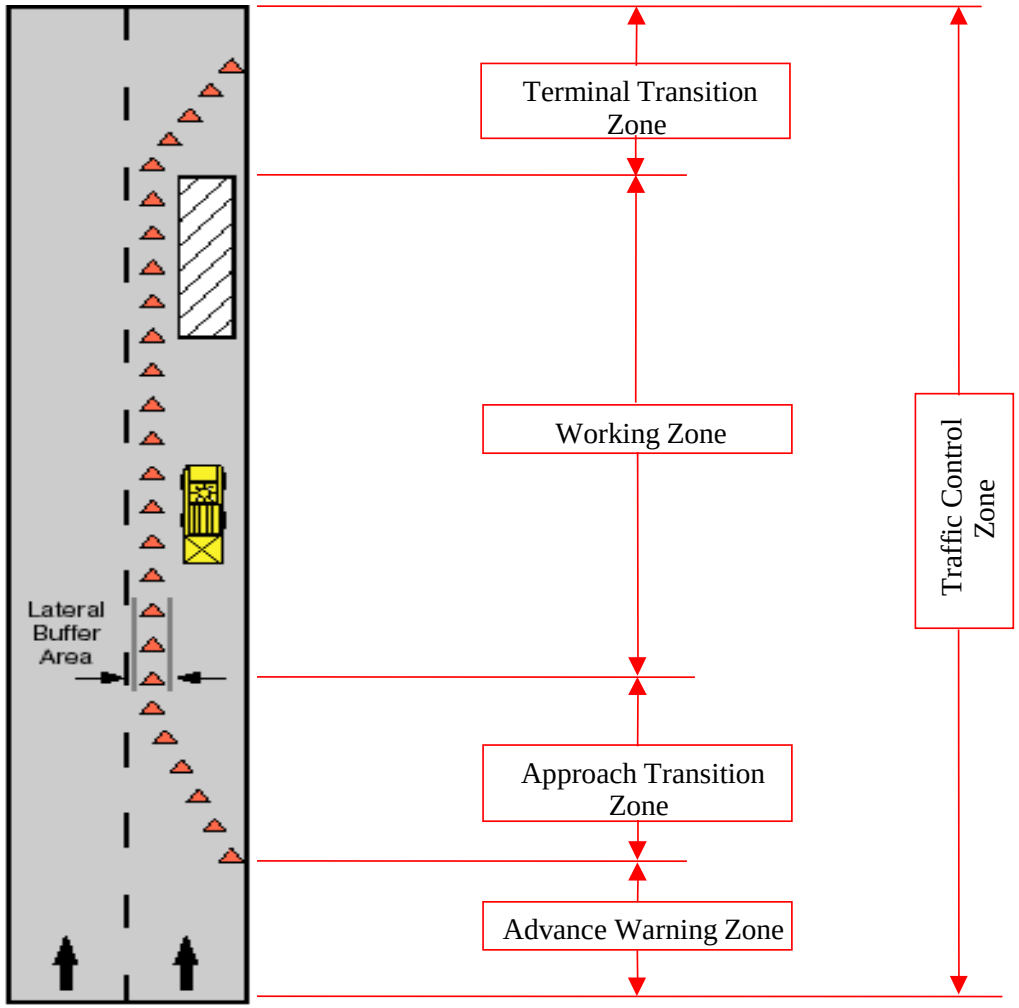
- **Prime cause of Accidents**
  - Increased strain on the driver
- **Guiding Principles**
  - Warn the road user clearly and sufficiently far in **advance**,
  - Provide safe & clearly marked lanes for **guiding** road users,
  - Provide safe & clearly **marked** buffer and work zones and
  - Provide suitable measures that **control** driver behaviour through construction zones.

Traffic Control Zones

- Work zone Traffic Management Plan (**TMP**)
  - Ensure impacts of road works to public is minimal
    - Consider temporary interruptions to vehicular and pedestrian traffic
    - Consider safety to the workers, pedestrians and vehicle users at all times

Traffic Control Zones

- **Four Zones**
  - Advance Warning
  - Begin Transition Zone
  - Working Zone
  - End Transition Zone



Traffic Control Zones

- **Advance Warning Area**
  - Notifies the driver of an impending temporary traffic control zone
  - This may vary from a single sign to a series of signs and/or flashing lights on a vehicle preceding the transition area
  - This should be placed ahead of the transition area and the length depends on factors such as
  - Speed Limit
  - Roadway Condition
  - Type of Road


CAUTION
DRIVE SLOW
CONSTRUCTION WORK
IN PROGRESS
100m AHEAD
START

Traffic Control Zones

- **Transition area**
  - Transition area involves the use of roadway tapers
  - Tapers are created using a series of channelizing devices or pavement markings placed out of or into the normal traffic path
- **Types of Tapers**
  - Merging
  - Shifting
  - Shoulder
  - Downstream
  - One-lane/two-way

Traffic Control Zones

- **Activity Area**
  - Road work is conducted with in this area
  - Made-up of the work space, the traffic space, and optional buffer spaces
- **Work space**
  - Portion of the roadway closed to traffic and set aside for workers, equipment, and material
  - It can be stationary or move as work is conducted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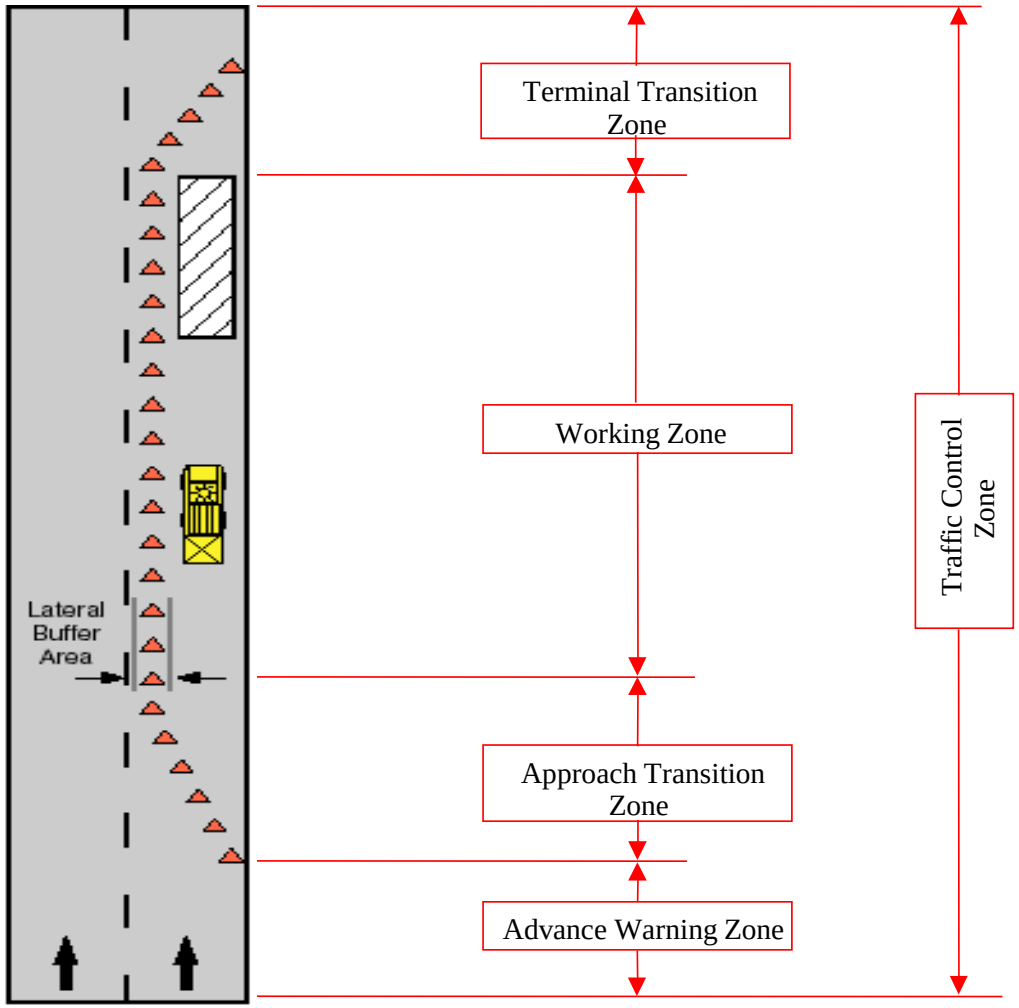
Traffic Control Zones

- **Termination area**
  - Used to return traffic to the normal traffic path
  - Tapers can be used to achieve re-routing of traffic back to the normal traffic lanes
  - It extends from the downstream end of the work area to an “END OF ROAD WORK” sign

Traffic Control Zones

- **Four Division**
  - Advance Warning
  - Begin Transition Zone
  - Working Zone
  - End Transition Zone



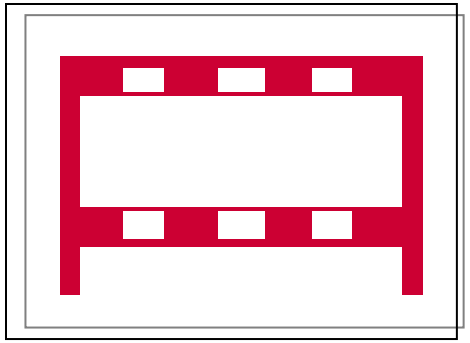
Recommended Length of Traffic Control Zones

Average Approach Speed (km/h)	Length of Advance Warning Zone (m)	Length of Approach Transition Zone (m)	Length of Working Zone (m)
50 or less	100	50	Varies
51-80	100-300	50-100	
81-100	300-500	100-200	
Over 100	1000	200-300	

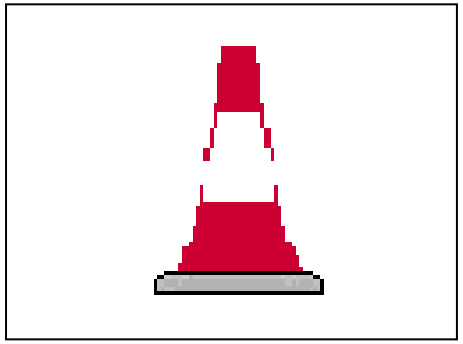
Traffic Control Devices

Road Signs

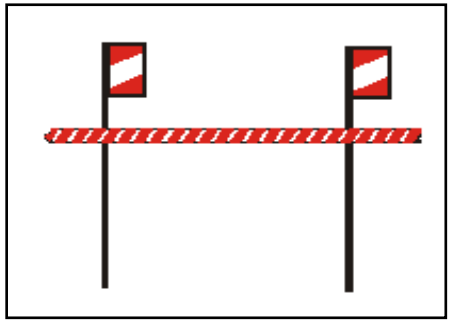
Barricades



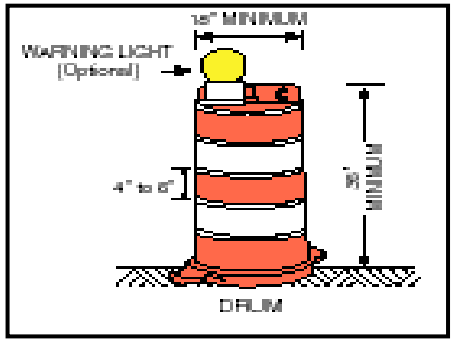
Traffic Cones



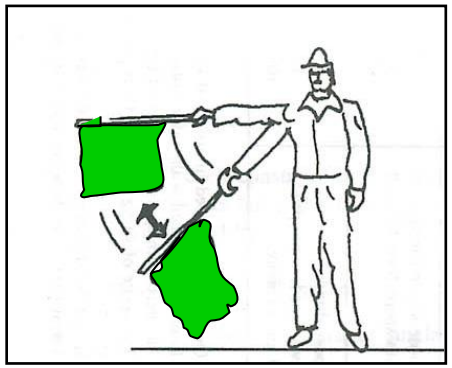
Metal Rod with Reflector



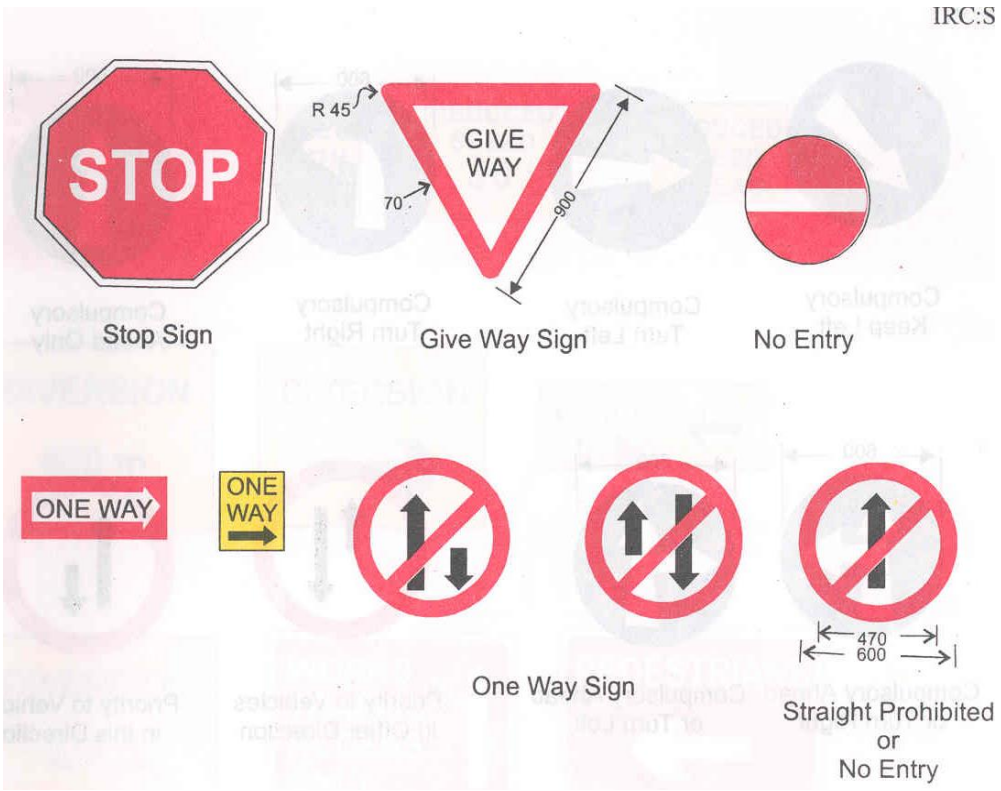
Drums



Flagman



Regulatory Signs Used for Work Zones



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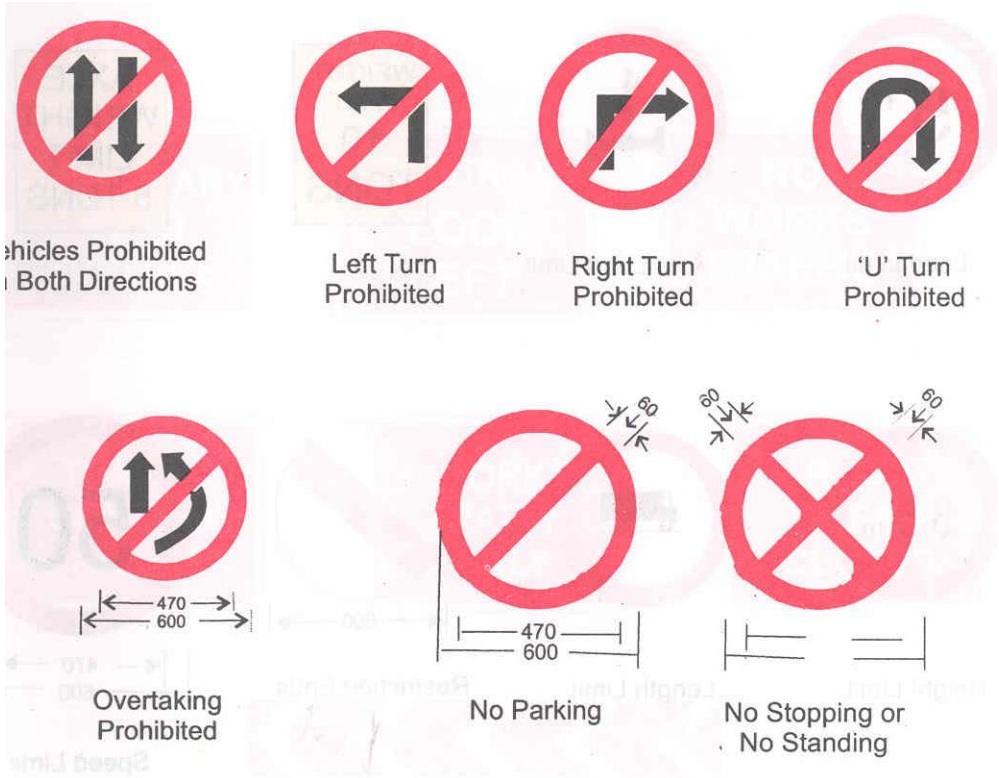

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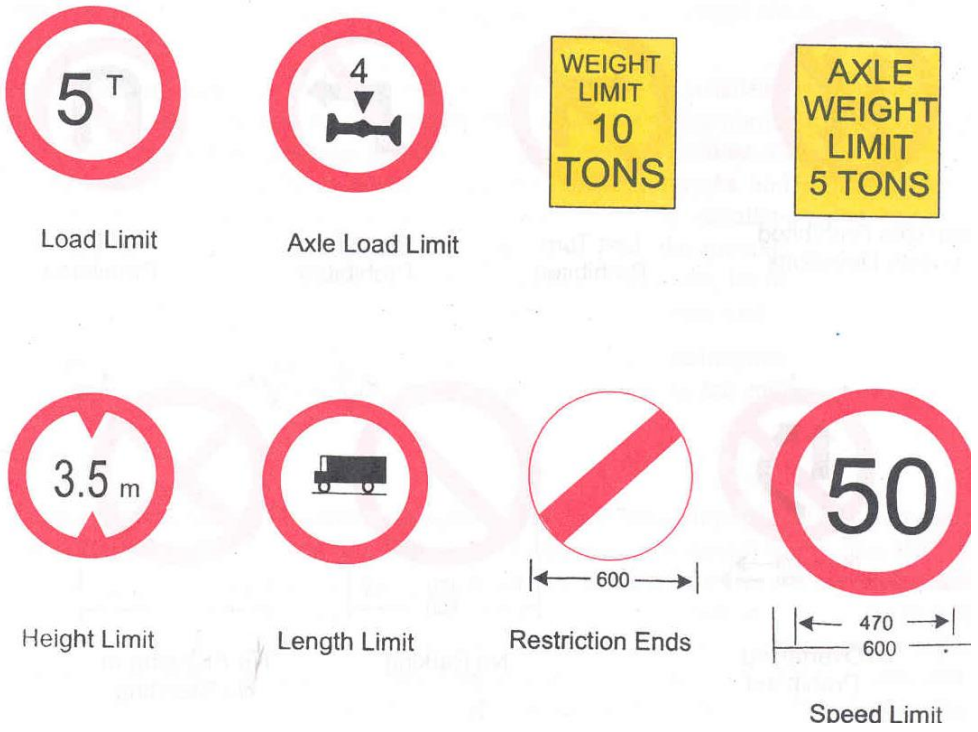

Cautionary Signs for Work Zones

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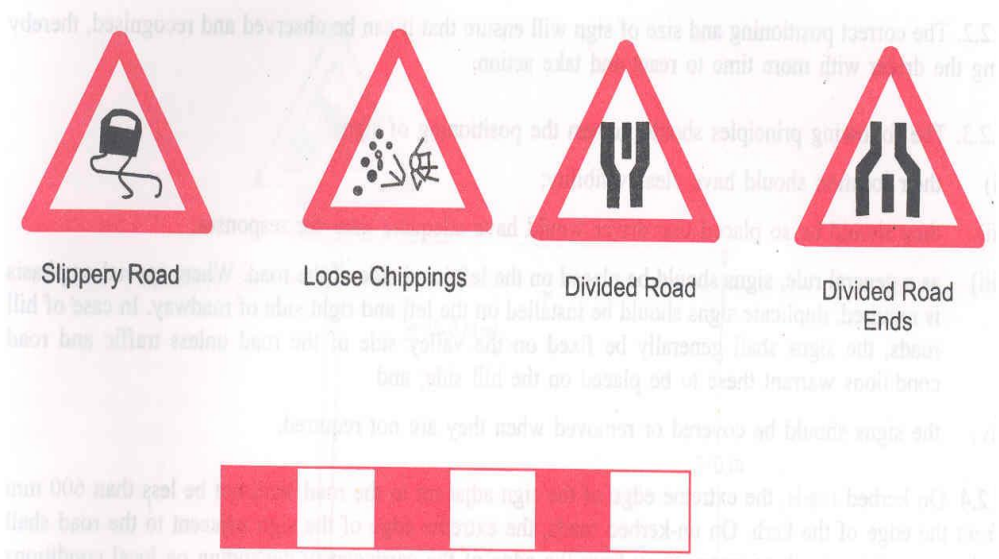

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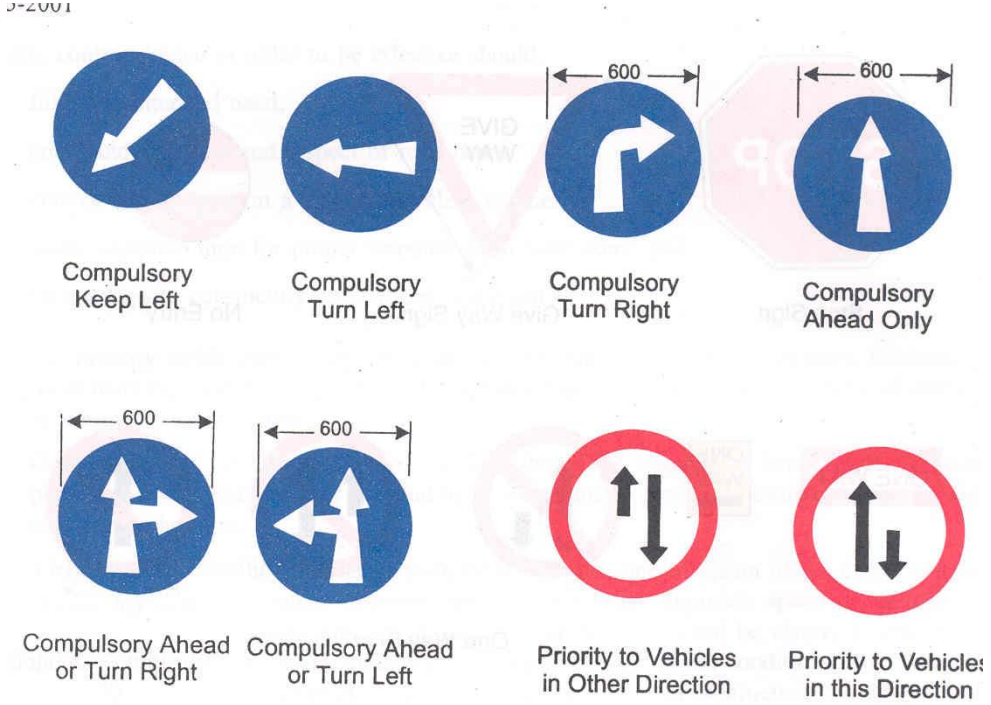

Informatory Signs for Work Zones

Informatory Signs for Work Zones

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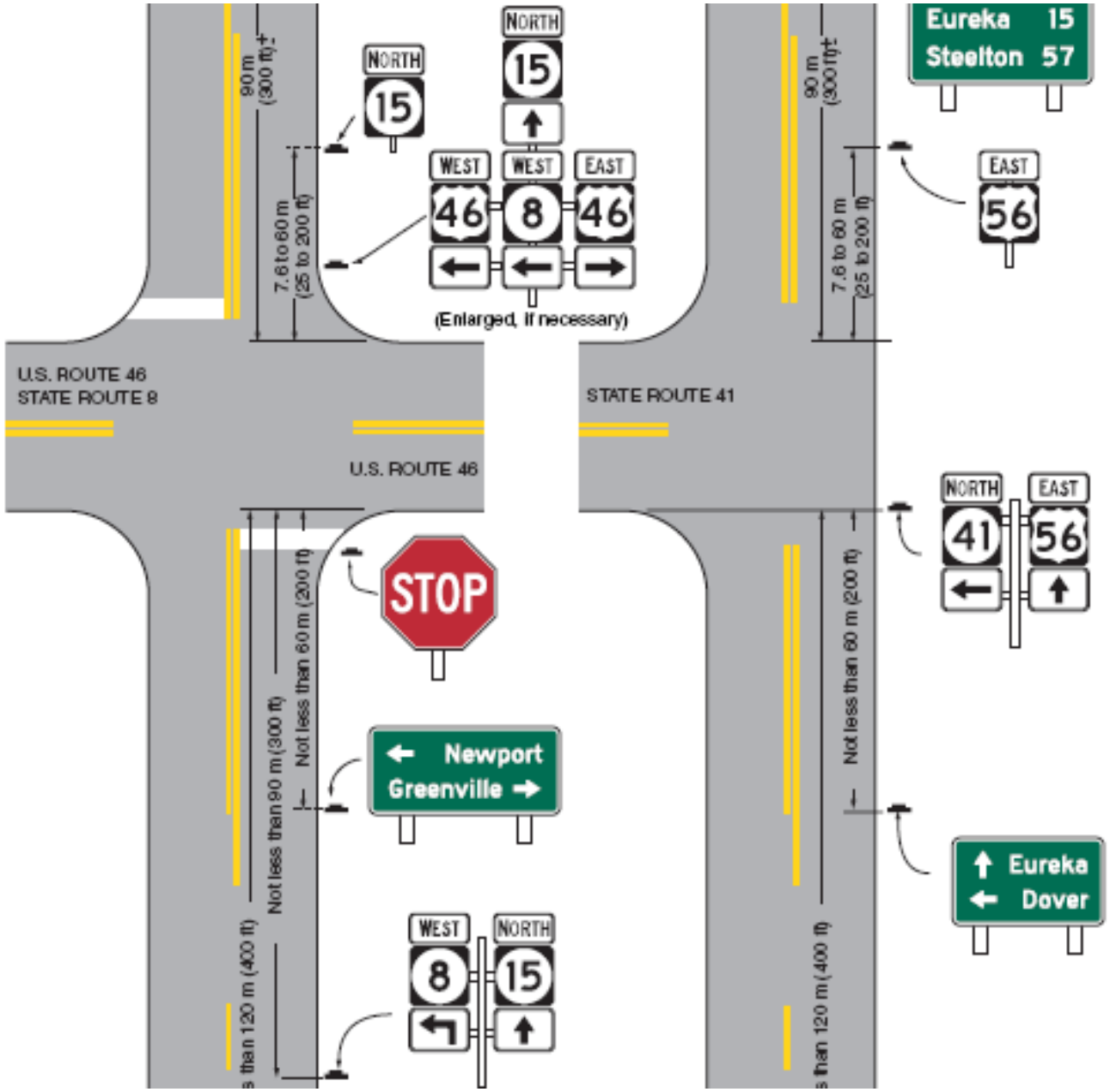
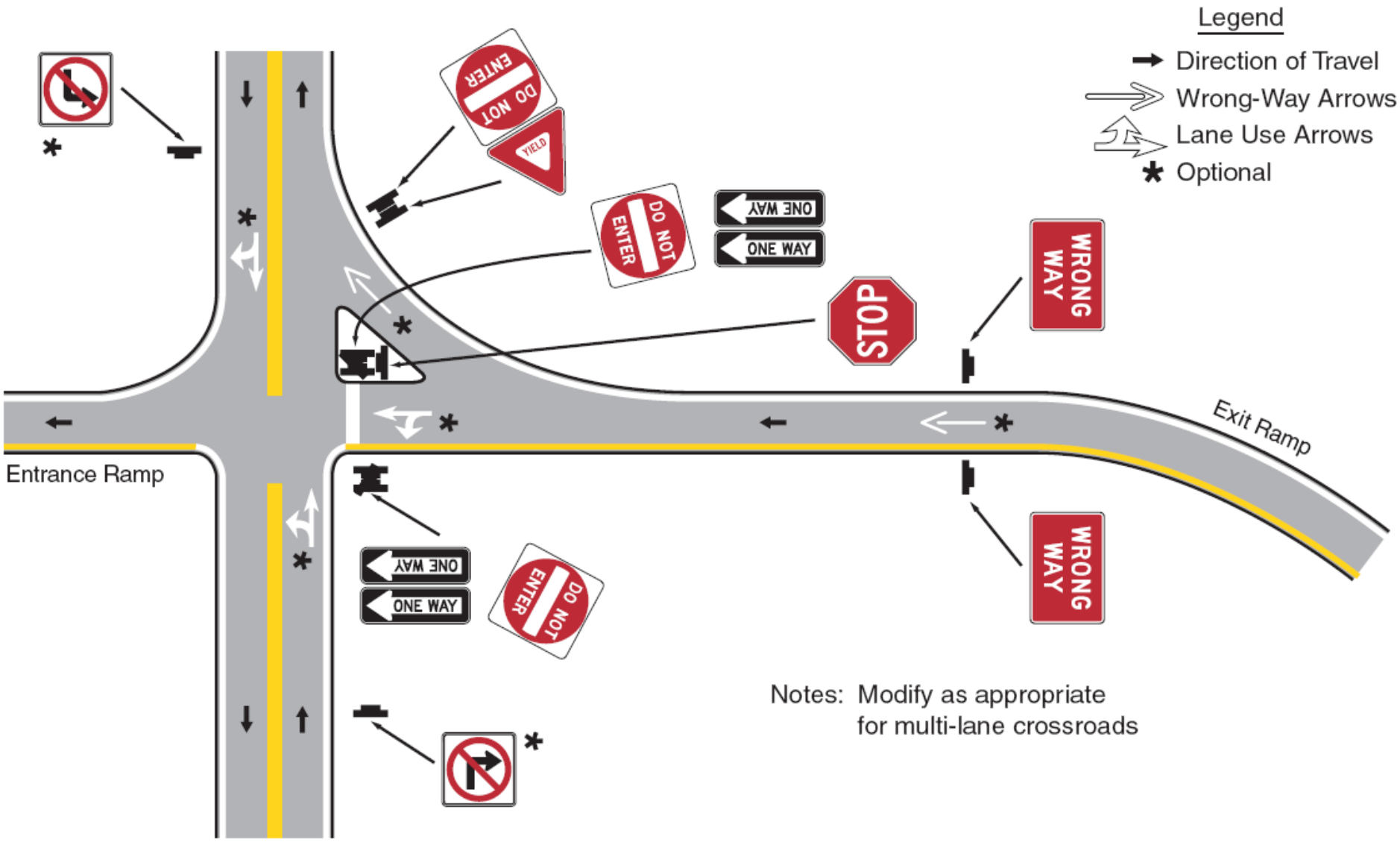
Traffic Signs



Traffic Signs



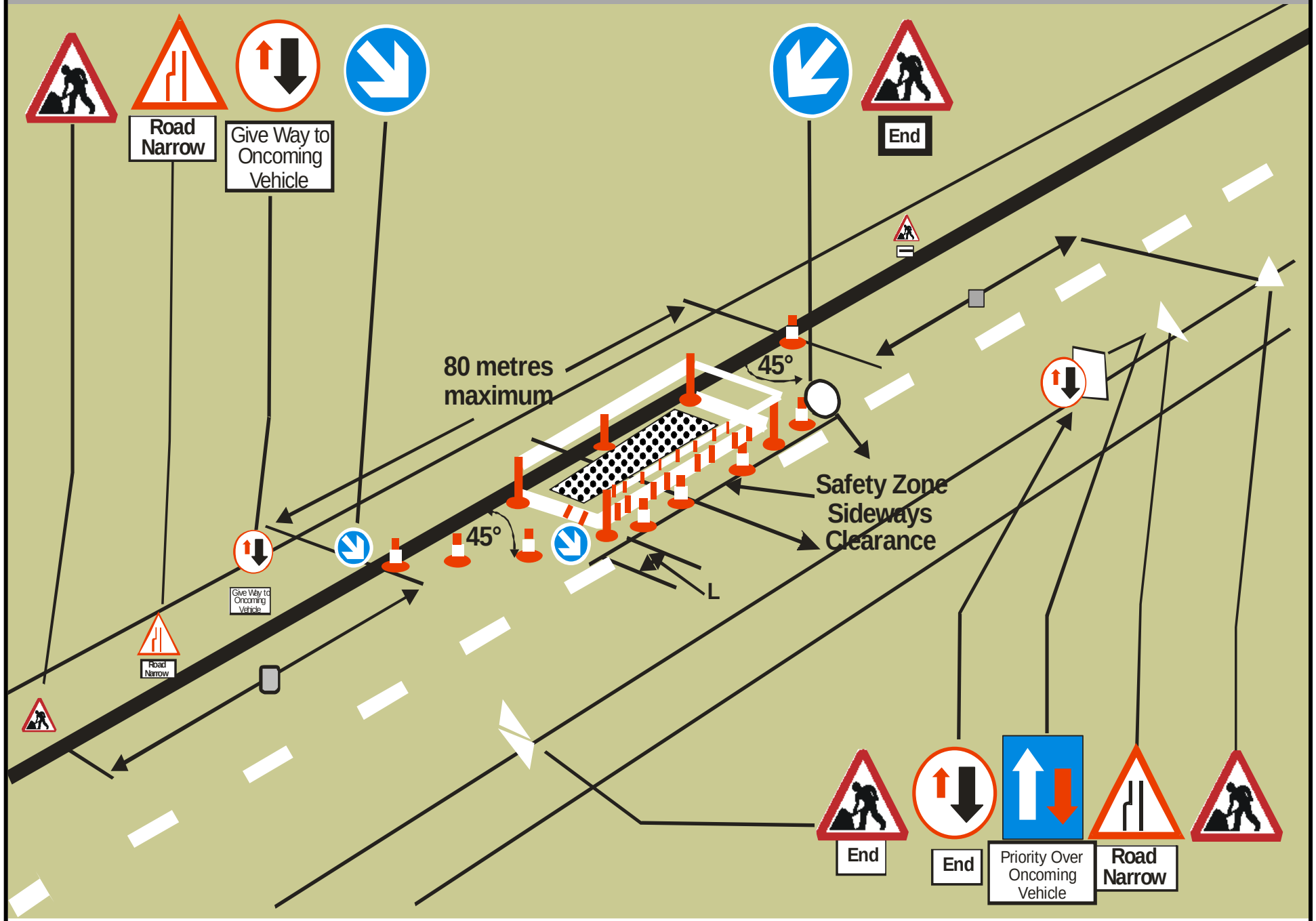
Sequence for Setting Out Signs

Sequence for Setting Out Signs

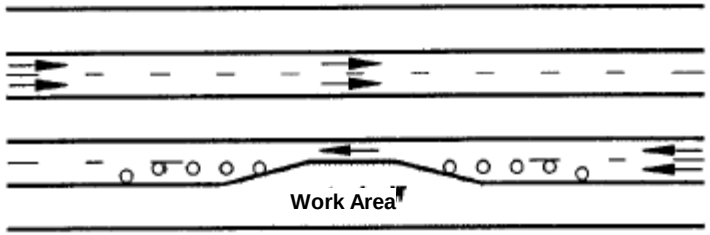
Use of Traffic Signs During Construction

2003

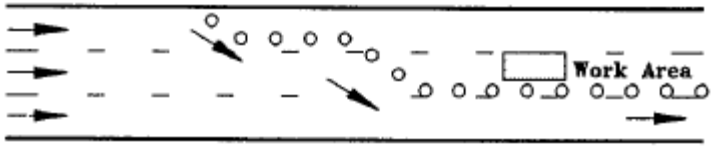
Traffic Control by Priority Signs



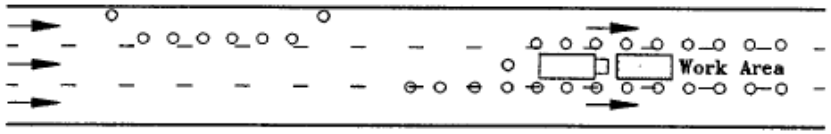
Work Zone Traffic Control Strategies



Single Lane Closure

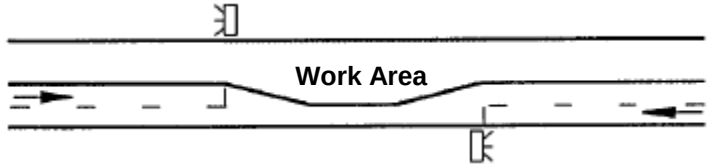


Multi Lane Closure

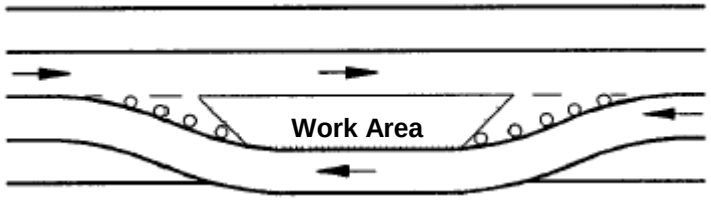


Traffic Splitting

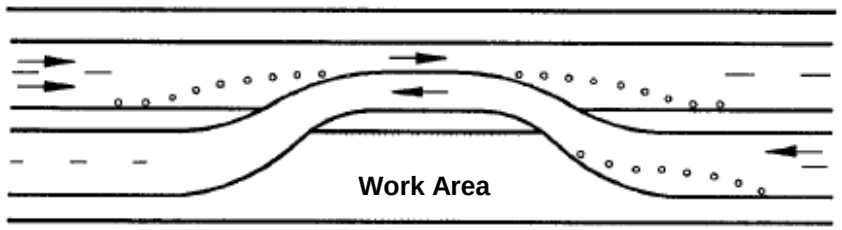
Work Zone Traffic Control Strategies



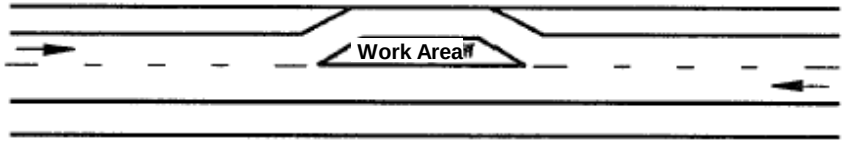
Shared right-of-way



Temporary By-pass



Cross-over strategy



Shoulder Utilization strategy

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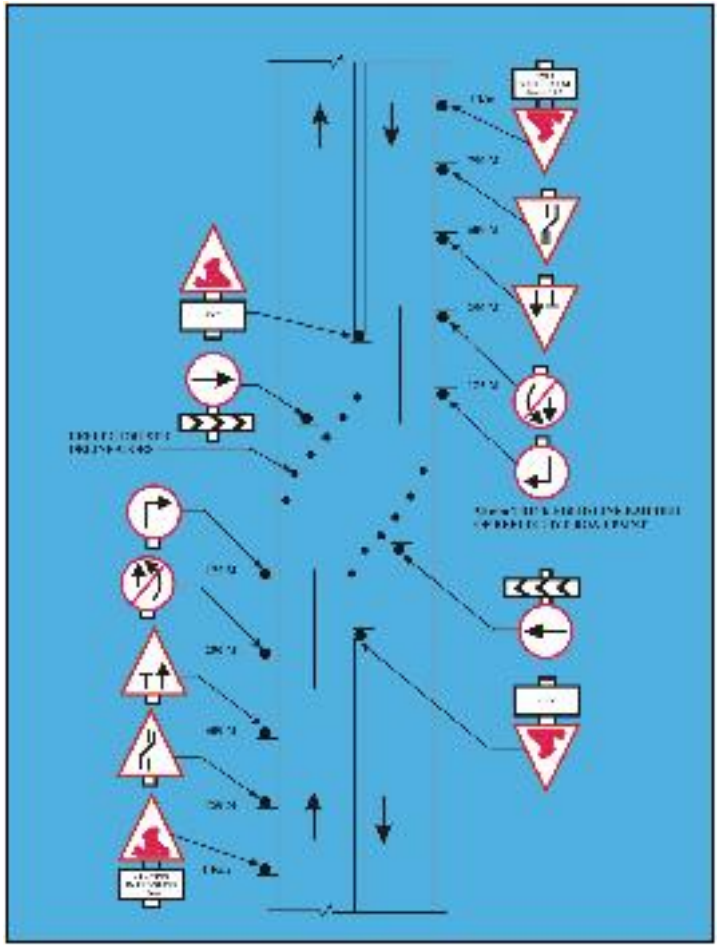
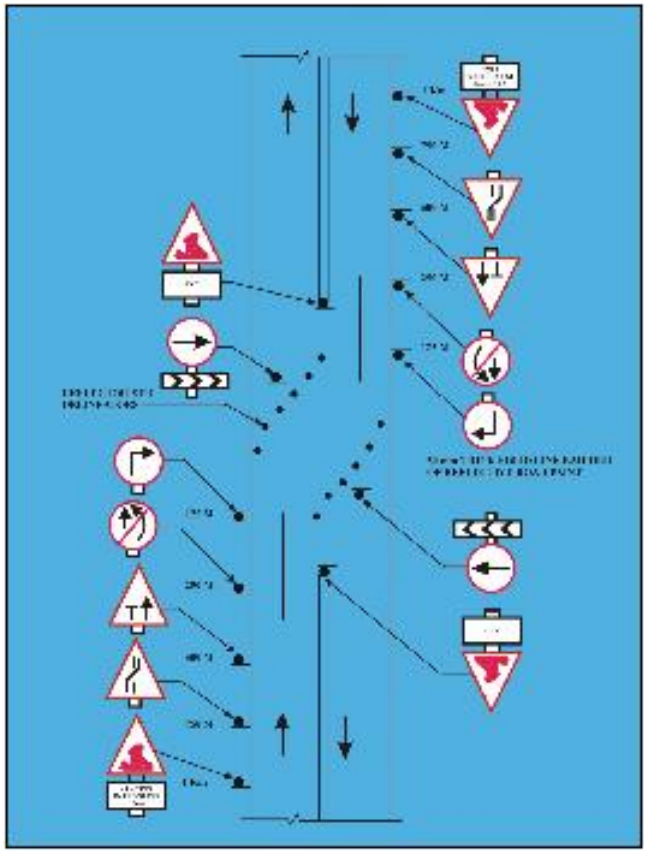
Work on Construction of Additional Carriageway

- Eccentric Widening- Centerline of the new highway shifted to the right or left of the existing carriageway centerline. It has 2 stages of construction.
  - First stage new carriageway constructed and existing used by traffic.



Eccentric Widening

Once the new carriageway is completed, two-way traffic is diverted onto the new carriageway and work on new carriageway is taken up.



Layout of Signs and Control Devices for Change in Carriageway Usage

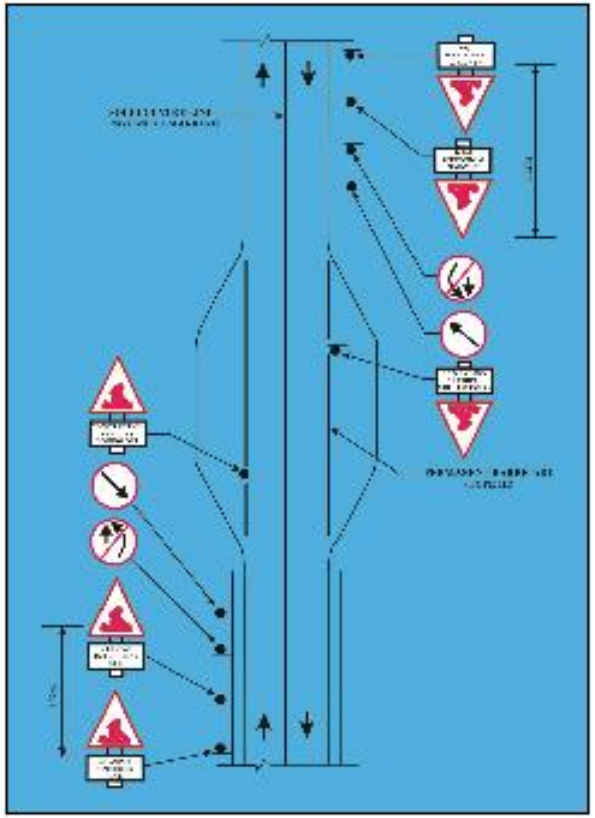
Work on Construction of Additional Carriageway

- **Co-centric Widening**
  - Stages of construction are:
    - ***Where service roads are provided :***

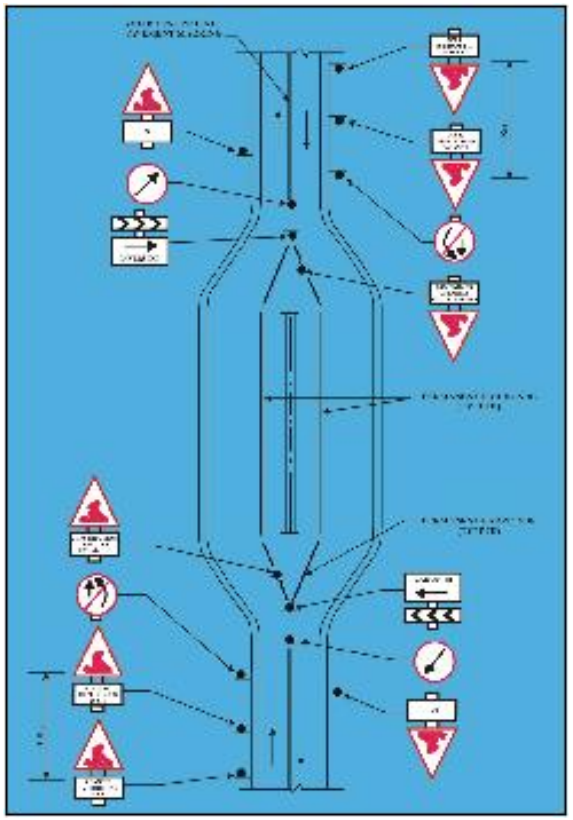
      Service roads on either side are constructed and traffic is diverted onto the service roads, one way each side. Once traffic is diverted, work on existing carriageway can be taken up.
    - ***Where services roads are not provided:***

      Single lane width of road is constructed on either side of existing carriageway. Traffic is diverted one way on each side, then work on existing carriageway is taken up.

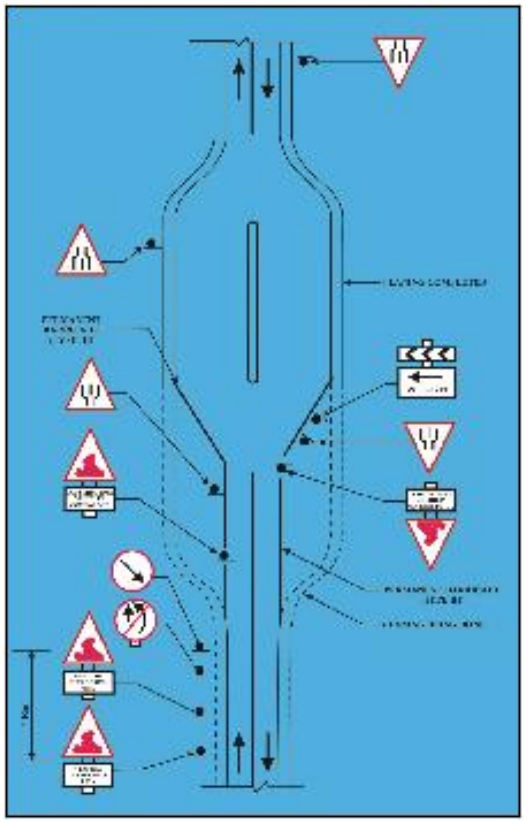
Co-centric Widening



Concentric Widening : Stage I – Construction of New Lanes



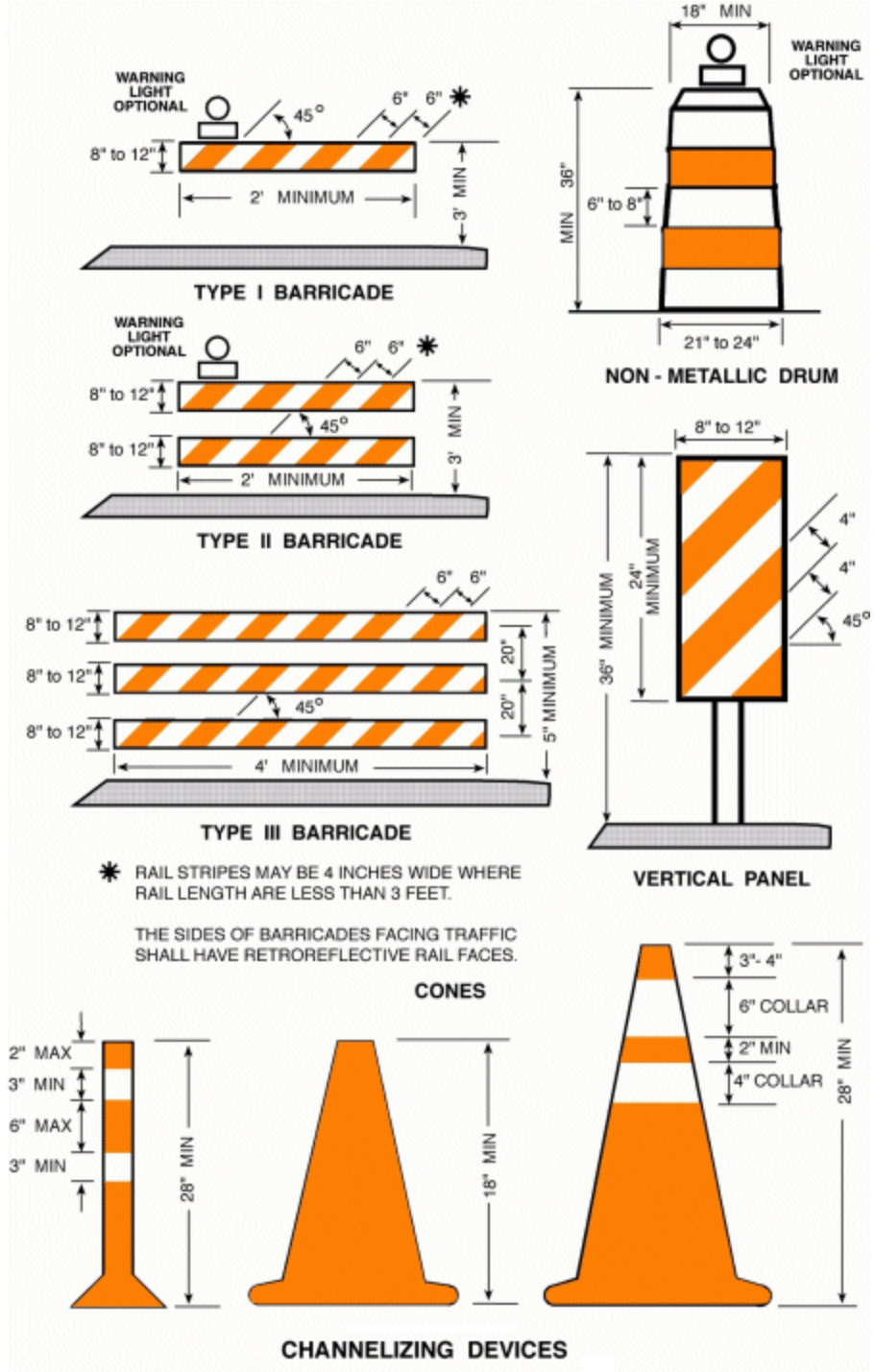
Concentric Widening : Stage II – Strengthening of Existing Carriageway and Median Construction



Concentric Widening : Stage III - Shifting of Work Zone

Channelizing Devices

- **Purpose**
  - Warn and Guide drivers through work activities in or near the roadway
  - Protect workers in the temporary traffic control zone
  - Types of channelizing devices include:
    - Cones
    - Tubular markers
    - Vertical panels,
    - Drums, Barricades, Portable barriers
    - Temporary raised islands


WARNING LIGHT OPTIONAL
45°
6" 6"
8" to 12"
2' MINIMUM
3' MIN
TYPE I BARRICADE
WARNING LIGHT OPTIONAL
6" 6"
8" to 12"
45°
8" to 12"
2' MINIMUM
3' MIN
TYPE II BARRICADE
6" 6"
8" to 12"
8" to 12"
8" to 12"
45°
20"
20"
5" MINIMUM
4' MINIMUM
TYPE III BARRICADE
18" MIN
WARNING LIGHT OPTIONAL
36" MIN
6" to 8"
21" to 24"
NON - METALLIC DRUM
8" to 12"
24" MINIMUM
36" MINIMUM
4"
4"
45°
VERTICAL PANEL
RAIL STRIPES MAY BE 4 INCHES WIDE WHERE RAIL LENGTH ARE LESS THAN 3 FEET.
THE SIDES OF BARRICADES FACING TRAFFIC SHALL HAVE RETROREFLECTIVE RAIL FACES.
CONES
2" MAX
3" MIN
6" MAX
3" MIN
28" MIN
18" MIN
3"- 4"
6" COLLAR
2" MIN
4" COLLAR
28" MIN
CHANNELIZING DEVICES

Pavement Markings

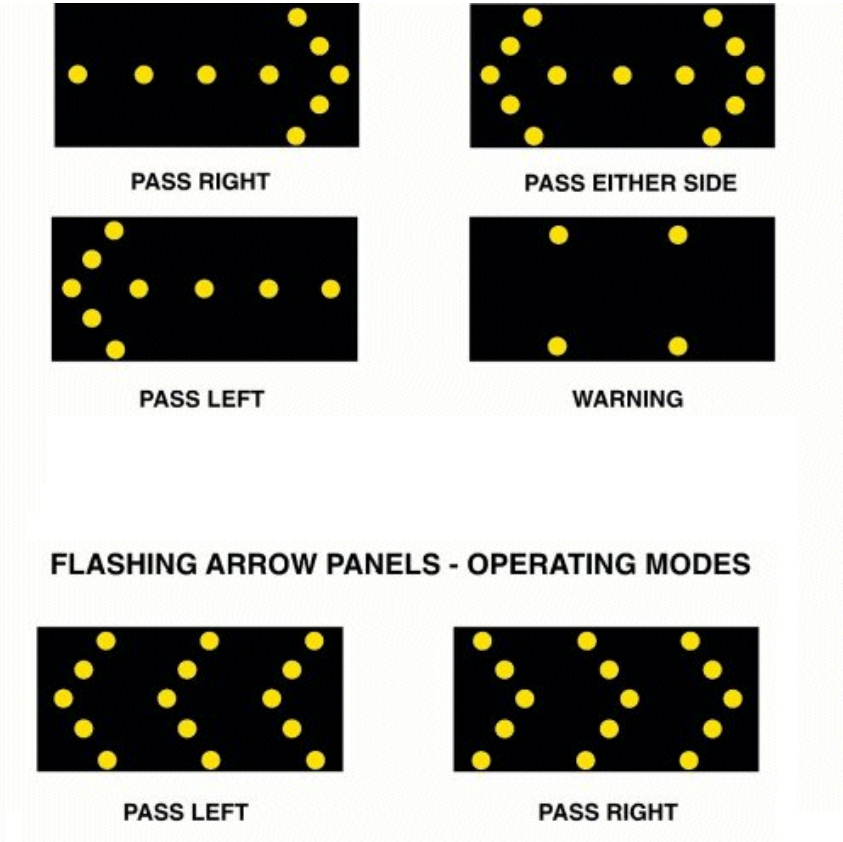
- **Purposes**
  - Must be comparable to the markings maintained along adjacent roadways
  - Pre-existing markings need to be evaluated for their potential to misguide vehicles
  - All markings and devices used to delineate vehicle paths and pedestrian routes should be evaluated in differing lighting and weather conditions to assess the risk of misguidance

Temporary Diversion

- **Overview**
  - Smooth horizontal and vertical curves
  - Strong and sturdy
  - Adequate traffic capacity
  - Ensure clear visibility
  - Barricading should prevent construction material falling onto the diversion

Arrow Displays

- **Features**
  - Sign with a matrix of elements
  - Provides additional warning or information
  - Facilitate enforce smooth direction enforcement



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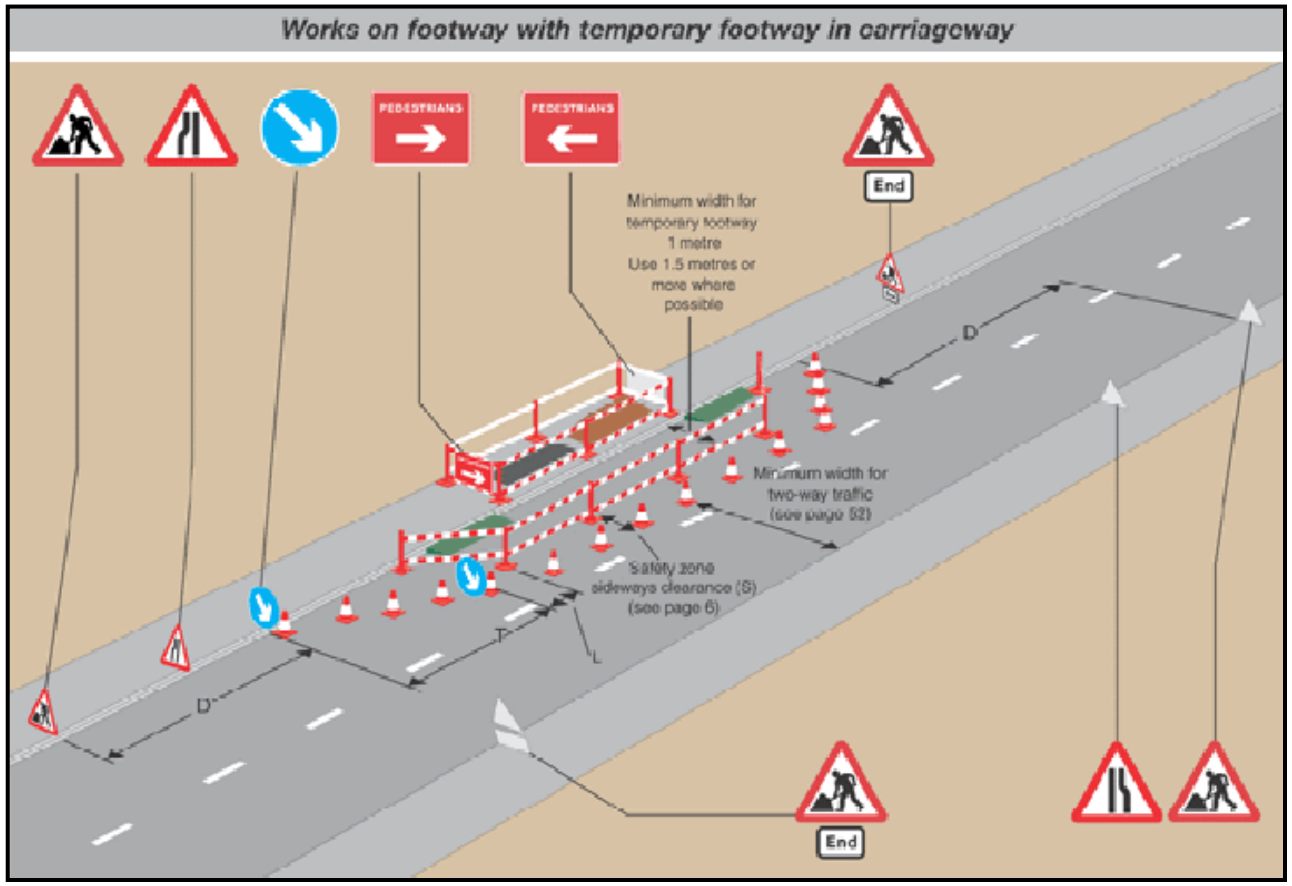
Ensuring Safety of Vulnerable Road Users

- **Features**
  - Provision of adequate pedestrian safety
  - No danger from falling objects or sharp edges and that they will not fall over or bump into anything.
  - Pedestrian Barriers
  - To mark out temporary footway and to protect pedestrians from traffic, excavations, plant or materials.
  - Pedestrian Crossings
- **Works on Footways**
  - Alternative safe route for pedestrians must be provided.
  - Pedestrian access to property must be provided.
  - Pedestrians should not be diverted onto an unguarded carriageway.
  - Guard and sign the approach on a temporary footway.

Ensuring Safety of Vulnerable Road Users



Works on Footway with Temporary Footway in Carriageway

Worker Safety

- **Issues**
  - Training workers about how to work safely next to traffic
  - Equipping workers with bright and highly visible clothing
  - Using barriers to separate work space from traffic


ROAD
WORK
AHEAD


BUCHANAN SKIP HIRE LTD
MAN
RF16 XVW

Safety of Workmen

Overview

- Workmen must be trained in use of tools and plant.
- Gum boots, spectacles, etc. must be given to persons handling bitumen.
- First-aid training be provided to all workmen and enough safety kits should be available at the site and
- Workers required on site during night hours must be provided with fluorescent yellow jackets with reflective tapes.

Safety Audit of Work Zone

Overview

– Road works sites involve a change of speed environment, additional conflicts and confined road space.

– To provide safety for works personnel as well as the travelling public.

– To ensure that any connection or crossing point of works traffic and public traffic is safe.

Implementation of Road Works TMP

- **Recommendations to MCGM**
  - Trained engineers of traffic management unit of MCGM should be involved in the preparation of work-zone Traffic Management Plan
  - The cost of implementing the Work-Zone TMP should be included in the cost of the road work
  - The contractor should implement the traffic management plan before starting the construction/maintenance work

Implementation of Road Works TMP

- **Recommendations to MCGM**
  - The working of the plan should be monitored day to day by the inspecting engineer
  - The status of implementation should be obtained from the contractor by using the checklist of items for work zone traffic management and safety

Checklist for Work Zone Traffic Management and Safety

ITEM	YES	NO	N/A
PLANNING			
1. Is an appropriate Traffic Control Plan (TCP) in place?			
2. Has impact of this TCP been assessed?			
3. Has possible traffic congestion been considered and steps taken to avoid it?			
4. Is traffic movement inhibited as little as possible ?			
5. Has proper access to side roads and properties been provided?			
6. Has access for emergency vehicles been provided?			
7. Have work zone speed limits been determined correctly?			
8. Are any required approvals for speed limits or lane closures in order?			
9. Is the traffic control plan available for inspection?			

Contd …

Checklist for Work Zone Traffic Management and Safety

ITEM	YES	NO	N/A
Work Zone Safety			
1. Have safety barriers (where used) been installed correctly? (e.g. units joined together; proper end treatment)			
2. Are clearances between workers and adjacent traffic being maintained?			
3. Has containment fence been installed where required?			
4. Is high visibility clothing appropriate for conditions and used correctly?			

Contd …

Checklist for Work Zone Traffic Management and Safety

ITEM	YES	NO	N/A
Traffic Control Devices			
1. Are traffic control devices appropriate for the project strategy?			
2. Are all road works signs and devices installed according to the plan?			
3. Have any contradictory, distracting or superfluous signs or markings been covered up or removed?			
4. Is advance warning distance appropriate for vehicles approaching at high speed? (e.g. Check sight distance, warning sign distance, height of signs above ground, vehicle queue length not beyond signage.)			
5. Are the signs free from damage and defect? (e.g. Must be reflective; easy to read; check shadow and glare issues.)			
6. Are sign sizes correct ?			
7. Are advance warning areas and traffic termination points properly marked?			

Contd …

Checklist for Work Zone Traffic Management and Safety

ITEM	YES	NO	N/A
Pedestrians			
1. Are pedestrians guided in a clear and positive manner?			
2. Are walkways clean and free of construction materials?			
3. Are walkways free of tripping hazards?			
4. Does the design meet the requirements of the elderly and disabled?			
5. Is barricading adequate to protect pedestrians from moving vehicles?			

Contd …

Checklist for Work Zone Traffic Management and Safety

ITEM	YES	NO	N/A
Traffic Control by Flaggers			
1. Are flaggers used only as last resort?			
2. Are flagger locations properly placed?			
3. Are all well trained and supervised?			
4. Are fluorescent vests worn during day time hours?			
5. Are refectories vests worn during night time hours?			
6. Are multiple flaggers in effective communications?			

Contd …

References

- IRC:SP:55-2001 Guidelines for Safety in Construction Zones.
- IRC:67-2001 Code of Practice for Road Signs (First Revision)
- IRC:79-1981 Recommended Practice for Road Delineators
- IRC:35-1997 Code of Practice for Road Markings (with Paints) (First Revision)
- IRC:30-1968 Standard Letters and Numerals of Different Heights for Use on Highway Signs

THANK YOU

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THANK YOU