

रोक चिन्ह
पर इन्तजार
करें

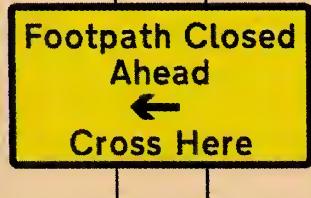
WHEN STOP
SIGN SHOWS
WAIT HERE



MEN AT WORK



PEDESTRIANS
ARE ALLOWED



GUIDELINES ON TRAFFIC MANAGEMENT IN WORK ZONES



INDIAN ROADS CONGRESS
2014



Digitized by the Internet Archive
in 2014

https://archive.org/details/govlawircy2014sp55_0

GUIDELINES ON TRAFFIC MANAGEMENT IN WORK ZONES

(First Revision)

Published by:

INDIAN ROADS CONGRESS

Kama Koti Marg,
Sector-6, R.K. Puram,
New Delhi-110 022

January, 2014

Price : ₹ 900/-

(Plus Packing & Postage)

First Published : July, 2001
Reprinted : November, 2004
Reprinted : October, 2010
First Revision : January, 2014

(All Rights Reserved. No part of this publication shall be reproduced, translated or transmitted in any form or by any means without the permission of the Indian Roads Congress)

Printed by India Offset Press, Delhi-110064

1000 Copies

Contents

	Page No
Personnel of the Highways Specifications and Standards Committee	i
Section 1 Introduction	1
1.1 Background	2
1.2 Purpose of Work Zone Traffic Management Plans (WTMPs)	3
1.3 Who Should Prepare WTMPs?	3
1.4 What Can Make WTMPs Effective?	4
1.5 Judicious Application of WTMPs	4
1.6 Legal Aspects of WTMPs	4
Section 2 Commonly Used Terms	6
Section 3 Principles of Work Zones Traffic Management Plans	16
3.1 Basic Principles of WTMP	16
3.2 Planning of WTMP	17
3.2.1 Provide safety for road users and workers	17
3.2.2 Minimize hindrance or delay to road users	17
3.2.3 Provide clear and positive guidance to road users	17
3.2.4 Ensure roadside safety maintenance	18
3.2.5 Ensure that planners and decision makers have the necessary knowledge	18
3.2.6 Provide good public relations	18
3.3 Primary Features of WTMP	18
3.4 Requirements of Work Zone Traffic Management Plan	20
3.5 WTMP in Urban Areas	20
3.6 WTMP in Project Development	21
Section 4 Temporary Traffic Control Zones	22
4.1 Introduction	22
4.2 Elements of Temporary Traffic Control Zone	22
4.2.1 Advance warning zone	22
4.2.2 Approach transition zone	25
4.2.3 Activity zone	25
4.2.4 Terminal transition zone	26
4.2.5 Work zone end	26

Section 5	Traffic Control Devices	27
5	Types of Devices	27
5.1	Road Signs	27
5.1.1	Retro reflective sheeting for road signs	28
5.1.2	Sign placement	28
5.1.3	Design of signs	30
5.1.4	Regulatory signs	30
5.1.5	Warning signs	37
5.1.6	Informatory signs	43
5.2	Channelizing Devices	46
5.2.1	Traffic cones	47
5.2.2	Tubular markers	48
5.2.3	Hazard markers	49
5.2.4	Drums	50
5.2.5	Barricades	50
5.2.6	Direction indicator barricades	54
5.2.7	New jersey barrier	54
5.2.8	Water-filled barricades	55
5.2.9	Detectable edging for pedestrians	57
5.2.10	Delineators	57
5.3	Temporary Pavement Markings & Road Studs	58
5.3.1	Road stud	59
5.4	Lighting Devices & Variable Message Signs	59
5.4.1	Lighting devices	59
5.4.2	Floodlights	59
5.4.3	Flashing warning beacons	60
5.4.4	Warning lights	61
5.4.5	Temporary traffic control singals	61
5.4.6	Portable variable message signs	62
5.4.7	Arrow boards	63
Section 6	Measures for Vulnerable Road Users (VRUs)	67
6.1	Measures for VRUs	67
6.2	Guidance	67
6.3	Barriers for Pedestrians & Cyclist	67

6.4	Works on Footpath: Alternative Way for Pedestrians	69
6.5	Speed Reduction Measures	70
Section 7	Traffic Management Practices at Worksites	72
7	Introduction	72
7.1	Alternate One Way Operations	72
7.1.1	Traffic control by give and take system	73
7.1.2	Traffic control by priority signs	73
7.1.3	Traffic control by stop/go boards	74
7.1.4	Traffic control by portable traffic signals	74
7.2	Detours	76
7.3	Diversions	76
7.4	Full Road Closures	76
7.5	Intermittent Closures	76
7.6	Lane Closures	79
7.7	Lane Constrictions	79
7.8	Median Crossovers	79
7.9	Use of Shoulder as a Travel Lane	82
7.10	Night Construction	82
7.11	Advantages and Disadvantages of Work Zone Design Strategies	82
Section 8	Roles and Responsibilities	84
8.1	Introduction	84
8.2	Critical Players or Stakeholders	84
8.2.1	Road authority	84
8.2.2	Road operator	85
8.2.3	Project director/in-charge	86
8.2.4	Designer	86
8.2.5	Road safety auditors	87
8.2.6	Contractor	87
8.2.7	Concessionaire	88
8.2.8	Supervision consultant/independent/resident Engineer	88
8.2.9	Local police	88
8.2.10	General public/community	89

Section 9	Deployment of Personnel and Safety Compliance	90
9.1	Introduction	90
9.2	Deployment of Flagman	90
9.3	Reflective Clothing	91
9.4	Roll Up Signs	92
9.5	Protective Gears for Workers	93
Section 10	Typical Applications	95
10.1	Introduction	95
10.2	Typical Layouts	95

**PERSONNEL OF THE HIGHWAYS SPECIFICATIONS
AND STANDARDS COMMITTEE**

(As on 19th July, 2013)

1.	Kandasamy, C. (Convenor)	Director General (RD) & Spl. Secy. to Govt. of India, Ministry of Road Transport & Highways, Transport Bhavan, New Delhi
2.	Patankar, V.L. (Co-Convenor)	Addl. Director General, Ministry of Road Transport & Highways, Transport Bhavan, New Delhi
3.	Kumar, Manoj (Member-Secretary)	The Chief Engineer (R) S,R&T, Ministry of Road Transport & Highways, Transport Bhavan, New Delhi
Members		
4.	Basu, S.B.	Chief Engineer (Retd.) MORTH, New Delhi
5.	Bongirwar, P.L.	Advisor, L & T, Mumbai
6.	Bose, Dr. Sunil	Head, FPC Divn. CRRI (Retd.), Faridabad
7.	Duhsaka, Vanlal	Chief Engineer, PWD (Highways), Aizwal (Mizoram)
8.	Gangopadhyay, Dr. S.	Director, Central Road Research Institute, New Delhi
9.	Gupta, D.P.	DG(RD) & AS (Retd.), MORTH, New Delhi
10.	Jain, R.K.	Chief Engineer (Retd.), Haryana PWD, Sonipat
11.	Jain, N.S.	Chief Engineer (Retd.), MORTH, New Delhi
12.	Jain, Dr. S.S.	Professor & Coordinator, Centre of Transportation Engg., Deptt. of Civil Engg., IIT Roorkee, Roorkee
13.	Kadiyali, Dr. L.R.	Chief Executive, L.R. Kadiyali & Associates, New Delhi
14.	Kumar, Ashok	Chief Engineer, (Retd), MORTH, New Delhi
15.	Kurian, Jose	Chief Engineer, DTTDC Ltd., New Delhi
16.	Kumar, Mahesh	Engineer-in-Chief, Haryana PWD, Chandigarh
17.	Kumar, Satander	Ex-Scientist, CRRI, New Delhi
18.	Lal, Chaman	Engineer-in-Chief, Haryana State Agriculture Marketing Board Panchkula (Haryana)
19.	Manchanda, R.K.	Intercontinental Consultants and Technocrats Pvt. Ltd., New Delhi.
20.	Marwah, S.K.	Addl. Director General, (Retd.), MORTH, New Delhi
21.	Pandey, R.K.	Chief Engineer (Planning), MORTH, New Delhi
22.	Pateriya, Dr. I.K.	Director (Tech.), National Rural Road Development Agency, (Min. of Rural Development), New Delhi

23.	Pradhan, B.C.	Chief Engineer, National Highways, Bhubaneshwar
24.	Prasad, D.N.	Chief Engineer, (NH), RCD, Patna
25.	Rao, P.J.	Consulting Engineer, H.No. 399, Sector-19, Faridabad
26.	Reddy, K. Siva	Engineer-in-Chief (R&B) Admn., Road & Building Deptt. Hyderabad
27.	Representative of BRO	(Shri B.B. Lal), Dpt. DG, HQ DGBR, New Delhi-110 010
28.	Sarkar, Dr. P.K.	Professor, Deptt. of Transport Planning, School of Planning & Architecture, New Delhi
29.	Sharma, Arun Kumar	CEO (Highways), GMR Highways Limited, Bangalore
30.	Sharma, M.P.	Member (Technical), National Highways Authority of India, New Delhi
31.	Sharma, S.C.	DG(RD) & AS (Retd.), MORTH, New Delhi
32.	Sinha, A.V.	DG(RD) & SS (Retd.) MORTH New Delhi
33.	Singh, B.N.	Member (Projects), National Highways Authority of India, New Delhi
34.	Singh, Nirmal Jit	DG (RD) & SS (Retd.), MORTH, New Delhi
35.	Vasava, S.B.	Chief Engineer & Addl. Secretary (Panchayat) Roads & Building Dept., Gandhinagar
36.	Yadav, Dr. V.K.	Addl. Director General, DGBR, New Delhi

Corresponding Members

1.	Bhattacharya, C.C.	DG(RD) & AS (Retd.) MORTH, New Delhi
2.	Das, Dr. Animesh	Associate Professor, IIT, Kanpur
3.	Justo, Dr. C.E.G.	334, 14 th Main, 25 th Cross, Banashankari 2nd Stage, Bangalore-560 070.
4.	Momin, S.S.	(Past President, IRC) 604 A, Israni Tower, Mumbai
5.	Pandey, Prof. B.B.	Advisor, IIT Kharagpur, Kharagpur

Ex-Officio Members

1.	Kandasamy, C.	Director General (Road Development) & Special Secretary, MORTH and President, IRC, New Delhi
2.	Prasad, Vishnu Shankar	Secretary General, Indian Roads Congress, New Delhi

GUIDELINES ON TRAFFIC MANAGEMENT IN WORK ZONES

SECTION 1

INTRODUCTION

The Guidelines on Safety in Road Construction Zones; IRC:SP:55 was first published by Indian Roads Congress in 2001. Since then, there has been development in road safety materials & technology. Therefore, a need was felt to bring out revised version of Guidelines to include latest technology of Traffic Management and Road Safety Aspect during construction. Accordingly, the work of revision of these Guidelines was taken up by the Transport Planning, Traffic Engineering and Road Safety Committee (H-1) during the tenure 2009-2011 under Convenorship of Shri S.C. Sharma. The first draft of revised document was prepared by the Sub-group comprising Shri D.P. Gupta, Dr. Geetam Tiwari, Ms. Nimisha Pal, Shri Sudhir Kumar, Dr. M. Parida, Dr. Surinder Mohan, and Shri Pawan Kumar Singh. This draft was discussed in various meetings of H-1 Committee during the tenure 2009-2011.

The H-1 Committee was reconstituted in 2012 and was renamed as Transport Planning and Traffic Engineering Committee. The reconstituted H-1 formed a new sub-group comprising Shri A.P. Bahadur Prof. P.K. Sikdar, Dr. T.S. Reddy, Dr. S. Velmurugan and Mr. Jacob George. The draft prepared by the Sub-group was discussed in various meetings of H-1 Committee and the document was subsequently approved by the H-1 Committee in its meeting held on 23.3.2013 for placing before the HSS Committee. The same draft was placed before the Highways Specifications and Standards Committee (HSS) during its meeting held on 19th July, 2013 and the HSS Committee approved this document subject to modifications in light of comments of members offered during the meeting. The Executive Committee in its meeting held on 31st July, 2013 approved the same document for placing it before the Council. The Council in its 200th meeting held at New Delhi on 11th and 12th August, 2013 approved the draft “Guidelines on Traffic Management in Work Zones” (First Revision) subject to modifications in the light of comments offered during the meeting and authorized Convener of HSS Committee to finalize the document for printing.

The composition of the H-1 Committee is as given below:

Dr. S. Gangopadhyay	—	Convener
S.K. Marwah	—	Co-Convener
Dr. S. Velmurugan	—	Member Secretary

Members

A.P. Bahadur	D.K. Mohapatra
Amandeep Singh	D.P. Gupta
Ashok Bhattacharjee	Dr. Bhargab Maitra
D. Sanyal	Dr. Geetam Tiwari

Dr. L.R. Kadiyali	R.K. Singh
Dr. M.R. Tagore	S.C. Sharma
Nimisha Pal	Subhash Chand
Nirmaljit Singh	Sudershan K. Popli
Pawan Kumar Singh	Sudhir Kumar
Prof. P.K. Sikdar	Surinder Mohan
Dr. P.K. Sarkar	The AIG Police, Haryana
Dr. Satish Chandra	The Jt. CP (Traffic), New Delhi
H.C. Sethi	W. Blah

Corresponding Members

Dr. C.E.G Justo	Dr. T.S. Reddy
	Gyanendra Singh

Co-opted Member

Jacob George

Ex-Officio Members

C. Kandasamy	Director General (Road Development) & Special Secretary, MoRT&H and President, IRC
Vishnu Shankar Prasad	Secretary General, IRC

1.1 Background

The road construction and maintenance activities are the integral part of road network development particularly for developing and transitional economies. Improving and expanding the roadway network is critical to economic development as well as the quality of life and, these activities create work zones in the network. The road work zones are areas of conflict between normal operating traffic, construction workers, road building machineries and construction traffic. If it is a construction of new road, normal operating traffic will not be there but the care has to be taken to avoid and or remove conflicts between workers and construction machineries and construction traffic. Problem becomes more serious if it is an urban road with significant proportion of vulnerable road users.

Work zone accidents are caused by several factors such as frequently changing environment that occurs during road work whereby the driver is often surprised, insufficient warning signs for normal and construction traffic, lack of audible warning to workers and, inadequate provisions of safety devices to protect workers. At most work zones, normal traffic is never more than 15 meters away from construction activities. Major contributing factors to work zone accidents

are not paying sufficient attention, going too fast for the prevailing conditions, failure to yield the right-of-way and, following too close. An ideal way to reduce work zone accidents is to create a working area that does not influence the normal traffic flow by segregating and shielding the site.

Massive road building and development is being taken up in India, under various schemes, such as National Highway Development Project (NHDP) and Prime Minister's Rural Road Development Schemes (PMGSY). Activities of improvement of about 45,000 kms of National Highways and around 400,000 kms of rural roads besides numerous urban roads are going on, all across the country. To ensure safety of all, there is a need to adopt an efficient and effective plan for management of traffic in work zones. Work Zone Traffic Management Plans (WTMPs) are required to meet the safety needs of regular traffic as well as works traffic, ensuring minimum disruption in access to properties and movement of pedestrians.

This document provides appropriate guidance and examples of best practice to improve the safety for all those who could be affected by work zones. These guidelines do not prohibit the use of new methods or devices provided that sufficient technical data is submitted to the Road Authority to demonstrate that the new method or device is equivalent and or better in quality, effectiveness, durability, and safety compliance as specified in these guidelines.

1.2 Purpose of Work Zone Traffic Management Plans (WTMPs)

The primary purpose of the Work Zone Traffic Management Plans (WTMPs) is to provide for the reasonably safe and efficient movement of road users through or around the work zones while reasonably protecting the workers and equipment. When the normal function of the roadway is affected with the presence of workers and equipment, the WTMP provides for continuity of the movement for motor vehicle, bicycle, and pedestrian traffic, transit operations, and access to properties and utilities.

It is equally important to ensure the safety of workers in Work Zones, who perform the varied tasks within the work space. Work zones present constantly changing conditions that are not expected by the road users, which creates an even higher degree of vulnerability for the workers present near the roadway. A concurrent objective of the WTMP is the efficient construction and maintenance of the highway, as well as efficient resolution of traffic incidents, if any, likely to occur in the work zone. The WTMP, therefore, should facilitate the smooth and efficient flow of traffic as well as safe working environment.

1.3 Who Should Prepare WTMPs?

One set of WTMPs cannot satisfy all conditions of a work zone, and defining all possible applications also may not be practically possible. Therefore, typical applications that depict common deployment of devices are described and illustrated in these guidelines. The site specific Work zone Traffic Management Plan would have to be prepared and implemented with concurrence of road authority. The WTMP selected for each situation would depend on the category of highway, geographical location, road user categories, physical constraints, and the distance/separation from the working space coupled with duration of operation.

WTMPs should be prepared by persons knowledgeable and experienced with respect to the fundamental principles of road safety, and the road work activities to be performed. The officer/engineer handling the task of preparing the WTMPs is required to be trained and certified. The design of the layout and selection and placement of traffic control devices for a WTMP would involve careful assessment of their effectiveness and considerable amount of judgment from traffic engineering and safety considerations.

1.4 What Can Make WTMPs Effective?

Improved road user performance can be better achieved through a well-prepared WTMP. The efforts towards publicity giving the nature of the work, the time and duration of its execution, the anticipated effects upon road users, and possible alternate routes and modes of travel are also important. Such programs would result in a significant reduction in the traffic conflicts.

The WTMP should be considered at the planning phase and continue through the design, construction, and restoration phases. Implementation of WTMPs shall be the responsibility of the road authority or a public body having jurisdiction over the work zone. The road authority through its Concessionaire/Contractor shall have statutory right for the implementation and enforcement of needed regulations and controls, speed zoning, and the management of traffic. Proper training of workers is necessary for effective implementation. Such statutory rights shall provide sufficient flexibility in the application of WTMP to meet the needs of changing conditions in the work zone.

1.5 Judicious Application of WTMPs

The principles described herein should be judiciously applied to both rural and urban roads. It would depend upon the hierarchy and type of road such as Expressways, dual/single carriageway National Highways, secondary/tertiary roads, urban arterial or access road. A rural National Highway would normally have higher speeds, fewer turning conflicts, and less conflict with pedestrians. An urban road or street is typically characterized by relatively low speeds, wide ranges of road user, varying traffic volumes, narrower roadway lanes, frequent intersections and property accesses, significant pedestrian activity, and more businesses and houses.

In these guidelines, the process of preparation and implementation of the WTMPs are also included to help in deciding the responsibilities and functions of the people involved in managing the work zone operations and safety.

1.6 Legal Aspects of WTMPs

Motor Vehicles Act 1988 provides the legal backing for erection of traffic signs and for traffic operations on roads. Most of the construction and maintenance activities (except for short term maintenance activities performed departmentally) in India are performed through contracts signed between road authority and Contractor/Concessionaire. These contract/Concession agreements signed between public authorities and private firms have their legal bases.

Normal contracts are generally governed by FIDIC Conditions of Contract which cover, besides other aspects, safety aspects in construction activities. For projects under Public Private Partnership (PPP), the Model Concession Agreement and its Schedule L provides for safety requirements for project development and construction.

Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act 1996, the Factories Act, 1948, Central Rules 1998, Building and Other Construction Workers' Welfare Cess Act, 1996 are the legal provisions governing the safety and welfare of construction workers in India.

The policy is to keep the closure of the roads to a minimum and to ensure that traffic is delayed as little as possible by the construction operations. Highest regard is to be given to traffic safety as well as to provide a safe working environment to the workmen. Before starting the construction work, which will influence traffic, the Contractor (Concessionaire, in cases of projects with private sector participation) has to get the legal permission of the road/traffic authority and local police about the means and extent of securing the construction zone. The traffic management strategies to be used at construction zones should ensure that traffic safety is an integral and high priority element of the project.

SECTION 2

COMMONLY USED TERMS

The commonly used terms in these guidelines are described hereunder and shall be applicable wherever they are used in this document.

<i>Activity Zone</i>	Activity Zone is the section of the highway where the construction activity is in progress and which comprises of work space, traffic space, and buffer space.
<i>Advance Warning Zone</i>	Advance Warning Zone is the section of the road in which the road users are warned in advance about the presence of work zone ahead and prepare them for the change in driving conditions.
<i>Advance Warning Length (AWL)</i>	The Advance Warning Length (AWL) is the road stretch (which is actually the Advance Warning Zone) in which series of warning signs are placed and the length depends upon the approach speed. It is the distance between first sign indicating the presence of road works ahead to the start of the Approach Transition Zone.
<i>Alternate One-Way Operations</i>	Alternate One-Way Operations is a traffic management practice where the Right of Way is allowed to be used alternatively by the traffic moving in one direction and then for the opposing directions, either with the help of flag men or traffic signal.
<i>Approach Longitudinal Buffer (ALB)</i>	Approach Longitudinal Buffer (ALB) is the buffer distance to be maintained on the approach side in the longitudinal direction. It is the distance between the first channelizing devices installed on the approach to the start of work area and would vary with the proposed operating speed.
<i>Approach Transition Zone</i>	The Approach Transition Zone is that section of work/construction zone, where the road users are redirected from their normal path through a laterally shifted path.
<i>Approach Taper Length (ATL)</i>	The Approach Taper Length (ATL) is the length in which the traffic is redirected from their normal path to a path parallel to work space and the length is directly proportional to the rate of taper, which also depends upon the operating speed.
<i>Arrow Boards</i>	Arrow Boards are the static or dynamic signs with a matrix of elements capable of either flashing or sequential displays. The Arrow Boards provide additional warning and directional guidance to assist in merging or diverging, and also to control the movement of the road users through or around a work zone.

Authority	Authority (Road Authority, Road Administration, and Transport Authority) is the legally responsible body for the provision of road and operation of the road traffic. There could be different authorities depending on the category of road and with different responsibilities.
Barricades	Barricades are traffic control devices intended to provide containment without significant deflection or deformation under impact and to redirect errant vehicles back to their designated travel path with least damages.
Barriers	Barriers are traffic control devices deployed to keep vehicles within their designated lanes/paths and prevent them from colliding with dangerous objects or workers and also to prevent vehicles to leave the roadway at hazardous location. These normally include all kinds of guardrails, plastic/concrete walls or similar devices like metal beam and wire rope crash barriers.
Buffer Space	The Buffer Space is a lateral and/or longitudinal width/length that separates the normal traffic flow from the work space or another unsafe area, and include some recovery space for an errant vehicle.
Built-up Area	Built-up Area means the area over which permanent or temporary structures are existing with different land uses along the road side.
Channelization	Channelization is a method of demarcating the flow path of different traffic streams using marking or raised physical islands or even the temporary barriers for guiding the traffic streams for merging or diverging at critical locations to minimize any confusion.
Channelizing Devices	Channelizing Devices are those used to physically create the channels of traffic movement paths to help guide the road users through the unusual conditions created by the work zone activities. They include cones, tubular markers, vertical panels, drums, barricades, pavement markings, road studs and different types of barriers.
Cold Applied Road Marking Paint	The Cold Applied Road Marking Paint is a solvent based cold paint material used for markings on pavement, which shall be applied on the asphalt/cement concrete road surface with a brush or spray arrangement.
Concessionaire	Concessionaire is the person or firm who enters into an agreement with the road (public) authority/agency as the private partner to build, maintain and operate the highway/road under one of the models of Public-Private Partnership (PPP).
Contractor	Contractor is the person or company responsible for the construction or maintenance of the road, and will be engaged for installing, operating and removing all the required arrangements for the traffic management in the work zone including traffic control devices.

<i>Crash Impact Attenuators</i>	Crash Impact Attenuators are the impact absorbing devices installed in highly hazardous locations so as to reduce kinetic energy of the errant or out of control vehicle and to stop or redirect the vehicle away from the main hazard with least damage to life and property.
<i>Crash worthiness</i>	Crash worthiness is the ability of a vehicle to protect its occupants during the impact with no or minimum injuries.
<i>Delineators</i>	Delineators are the devices with distinct visibility and reflectivity used to supplement the other normal traffic control devices, to delineate and guide the road users through the constrained or critical locations of the highway making the travel path clearly readable.
<i>Designer</i>	Designer is a technically qualified expert for designing the geometrics of roads/highways, traffic control measures, and also responsible for a safe and economic design of the traffic management plan for the work zone.
<i>Detectable Edging for Pedestrians</i>	Detectable Edging for Pedestrians are the clearly distinguishable alternative space or temporary walk-way created for pedestrians at the work zone of a road or highway.
<i>Detours</i>	Detours are the routes or re-directed vehicular movement paths through other links of the network, when a section of road is taken up completely for work, and the traffic is totally prevented from using this stretch of road. The traffic, in such case, will use nearby designated (duly signed) alternative route (detour) to bypass the work zone.
<i>Direction Indicator Barricades</i>	The Direction Indicator Barricades are channelizing devices consisting of one-direction large arrow signs mounted above, a horizontally aligned barrier with diagonal stripes of retro-reflective material on them.
<i>Diversion</i>	Diversion is a component of the work zone of the road section, where the traffic movement in one or both directions are organized through a temporary road constructed alongside the work zone, while the main carriageway or bridge/culvert is under construction. The diversion road is reconnected with the main/permanent road after the work zone.
<i>Drums</i>	Drums are used for segregating traffic from work space and also for delineating or channelizing; and are made of lightweight, flexible, and deformable materials of LDPE or plastic so that no damage is caused to the vehicle when stuck. They may be of bright red, yellow or white colors. They should be portable enough to be shifted from place to place within a temporary traffic control project to accommodate changing conditions but would remain in place for a prolonged period. Steel drums shall not be used.

<i>Exit Longitudinal Buffer (ELB)</i>	Exit Longitudinal Buffer (ELB) is the minimum buffer distance to be maintained on the leaving side in longitudinal direction from the end of channelizing devices including edge marking to the actual end of work area/space and would vary with proposed operating speed.
<i>Flagman</i>	The Flagman is the person who controls the traffic with Stop and Go boards in one-way operation of the traffic in the work zone. He also controls the movement of the construction vehicles in and out from the work space.
<i>Flashing Warning Beacons</i>	Flashing Warning Beacons are devices (operated electrically or solar charging) often used to supplement other traffic control devices to draw the attention of the road users, and can be a flashing red/yellow lights, operated generally 24 hours in the day.
<i>Floodlights</i>	Floodlights are high power lights operated using generator, and are used to illuminate the area in work zone when maintenance and/or construction activities on highways are carried out during night times, when traffic volume is relatively low.
<i>Full Road Closures</i>	Full Road Closure is traffic management practice in which a road is completely closed for traffic temporarily for construction or maintenance. This could be for short term or long term activity requiring detours.
<i>General public and Communities</i>	The General Public and Communities refer to the neighbourhoods and habitations along and around the construction zone, which are getting impacted by the road works.
<i>Give and Take System</i>	Give and Take System is the one-way system (especially for single lane carriageway) operating in alternate directions temporarily by stopping traffic of one direction and giving way to the traffic of the opposing direction. This practice is generally applicable for roads with very low traffic volume and that work is taken up over a very short stretch of road. The length will be such that the traffic approaching from both sides can see each other at the entry points, so that they can judge and decide whether to proceed or wait.
<i>Hand Paddles</i>	Hand Paddles are the devices (stop and go boards) used either to stop or allow traffic to proceed by the persons controlling one way system operating in alternate direction (e.g. alternate one-way system).
<i>Hazard Markers</i>	Hazard Markers are retro-reflective sign markers invariably placed in front of all exposed road side hazards adjacent to traffic movement for marking and delineating them.
<i>Hot Thermoplastic Paint</i>	Hot Thermoplastic Paint is the plastic road marking material that can be applied to road surface in a hot and molten stage for marking the pavement for the road markings.

<i>Informatory Signs</i>	Informatory Signs are the signs used to inform road users of the presence of road works ahead, and to direct/guide them with the information for safe movement through the construction zone using temporary diversions and detours etc.
<i>Intermittent Closure</i>	Intermittent Closure is a traffic management strategy in which traffic in one or both directions is stopped for a relatively short period to allow the critical construction activities, which may be hazardous for traffic, such as launching of bridge girders, and moving construction machinery, etc.
<i>Lanes Closure</i>	Lanes Closure is the operation in which one or more traffic lanes and any adjacent shoulder are closed to traffic, in case of a multi-lane highway, for carrying out the road works.
<i>Lane Constrictions</i>	Lane Constrictions is the situation, which entails reducing the width of one or more travel lanes, for carrying out road works. This permits traffic movement through the lanes with constrictions, but at a reduced speed.
<i>Lateral Buffer Space (LBS)</i>	Lateral Buffer Space (LBS) is the minimum buffer distance to be maintained in the lateral direction from the moving traffic, i.e. distance measured from outer edge line marking of the carriageway used by the traffic in the work zone and the edge of the work area constituting the actual work space.
<i>Lighting Devices</i>	Lighting Devices are the devices of either permanent or temporary lighting arrangement or the flashing lights used in work zones to make the work zones more conspicuous, and these are essentially required on high speed multi-lane highways. These may include floodlights, flashing beacons, warning lights, and steady-burning electric lamps and light strings used for delineation.
<i>Long Term Road Works</i>	Long term road works are stationary working zones, with traffic control devices in place, required to be there for more than 24 hours.
<i>Low Speed</i>	A low speed road would have a posted speed limit of 50 kmph or less.
<i>Low Volume Roads</i>	Low Volume Roads (LVRs) are normally considered as roads with relatively low use, an Average Daily Traffic (ADT) of less than 400 vehicles per day, design speeds typically less than 50 kmph, and corresponding geometry
<i>Marshaling Torch</i>	Marshaling Torch is the tough and durable hand flasher used by Marshalls and Flagmen, working on normal or rechargeable batteries with normal/LED bulbs and would provide warning signal for impending hazard or danger of construction work zone, repair sites, trenches, digging of road tunnels etc.

<i>Median Crossover</i>	Median crossover is a traffic management practice where traffic of one side of a divided carriageway is to be brought to the other side of the median due to road works or maintenance activities. This can be achieved with a series of warning signs placed on the approach to such work sites and at the median crossover portion so as to clearly delineate the diversion with barricades for appropriate channelization.
<i>Mobile Road Works</i>	Mobile road works are work zones with traffic control devices and safety equipment, which will continuously move forward to next spot, with progress of work.
<i>New Jersey Barrier</i>	New Jersey Barrier is a reinforced concrete barrier of a specific shape, used to separate moving traffic and work space, generally used in work sites of longer construction period. They are designed to minimize vehicle damage in cases of incidental contact while still preventing the crossover case of a head-on collision. Jersey barriers are also used to reroute traffic and protect pedestrians during highway construction.
<i>Normal Regulatory Signs</i>	The Normal Regulatory Signs are the circular shaped signs, either prohibitory or regulatory in nature for managing traffic movements. The shape, color scheme and size are same as that given in IRC:67 and used in work zones also.
<i>Ordinary Road Marking Paint</i>	Ordinary Road Marking Paint is the paint used for road markings in work zone, and this is very temporary marking and likely to last for a short period.
<i>Portable Traffic Signals</i>	Portable Traffic Signals are the traffic signals to regulate and control vehicular movement at work zones of small length and for short construction period.
<i>Portable Variable Message Signs</i>	Portable Variable Message Signs are the devices (made of LED based matrix boards) with the flexibility to display a variety of messages in work zones, pertinent to the on-going road works, conveying messages like direction of diversion and also warning messages for approaching drivers.
<i>Priority Signs</i>	Priority signs are road signs (showing the priority of traffic movement) installed in a work zone to establish the priority of traffic movement, where traffic control is required.
<i>Protective Gears for Workers</i>	Protective Gears for Workers are the high-visibility safety apparel (called PPE: personal protective equipments), headgear, boots, gloves, eye protector and protective jacket for the protection of all workers in the work zone.

<i>Reflective Clothing</i>	Reflective Clothing is the high visibility fluorescent clothing made of retro-reflective material, so that the presence of workers and those in work zone is conspicuous and can be easily seen by drivers in all weather and light conditions.
<i>Regulatory Signs</i>	Regulatory Signs are the signs to inform road users of traffic laws or regulations to be adhered to in work zones and also to indicate the legal validity that would not otherwise be apparent.
<i>Retro Reflective Sheeting</i>	Retro Reflective Sheeting has the ability of the surface to return light back to the source (the driver, whose headlight beam has fallen on the sign) and such sheeting is used for signs to be effective in dark hours or when outside light is insufficient.
<i>Road Operator</i>	Road Operator is responsible for operating a road network by law, legal act or contract. A Road Operator could be a department, agency, community or company and is the primary client or ordering body for the road works.
<i>Road Studs</i>	The Road Studs are raised Retro-Reflective Pavement Markers (RRPM) installed on road surface along with pavement markings to delineate the traffic paths/lanes in work zones and through diversions. These are also known as cats-eye and can be with fixed reflectors or solar powered blinking type.
<i>Road Users</i>	Road Users are all constituent modes of traffic using the work zone, including the Vulnerable Road Users (VRUs).
<i>Road Workers</i>	Road Workers includes all workers present in or around the work zone and involved in construction and management of works, including traffic management and any kind of surveying. Due to close proximity and exposure to the moving traffic in their workplace, road workers are vulnerable to hazards.
<i>Road Works</i>	Road Works include all activities for improving or expanding the road network as well as the maintenance activities that may require warning the traffic about the unusual situation likely to be encountered, which in turn will influence the safety of road users and/or road workers.
<i>Roll-up Signs</i>	Roll-up Signs are basically portable signs used in construction zones to guide the traffic for meeting emergency situations. Roll-up Signs shall be changeable and shall have provisions for fixing on different objects depending on the need.
<i>Safety Auditor</i>	Safety Auditor is an expert who undertakes the safety audit of the project in its planning, design, construction (including Work zone Traffic Management Plan) and operation and maintenance

<i>Shadow Vehicles</i>	Shadow Vehicles (security vehicles or service vehicles) are the moving trucks fitted with attenuators spaced at a short distance, giving physical protection to workers and equipment and machinery from traffic approaching from the rear. Similarly trailer-mounted attenuators may also be used as shadow vehicle to protect workers and machinery in work zone.
<i>Short Term Road Works</i>	Short term road works are stationary working zone with traffic control devices in place, required to be there for less than 24 hours. Short term road works are normally done during daylight in good visibility condition. However, they can be carried out during night also with adequate flood light.
<i>Speed Breakers</i>	Speed Breakers are the humps created for slowing down the traffic. They shall be constructed with premix bituminous concrete and shall be as per the design standards specified in this document. Rumble strips are also another kind of speed breaker.
<i>Stop/Go Boards</i>	The Stop/Go Boards are the hand held signs of circular shape to control traffic manually on alternate one-way operations.
<i>Supervision</i>	Supervision means all inspection and investigation done by an expert to improve the quality and safety of work zones.
<i>Temporary Traffic Control Zone</i>	Temporary Traffic Control Zone means the area of a roadway where traffic conditions are changed temporarily by the use of temporary traffic control devices, flaggers, police or other authorized personnel for facilitating the road works and to manage the normal traffic operations in a safe and efficient manner. A Temporary Traffic Control Zone starts from the first advance warning sign or flagger and extends through the last traffic control device where traffic returns to normal conditions.
<i>Temporary Traffic Control Signals</i>	Temporary Traffic Control Signals are erected temporarily and used to control road traffic through work zones in safe manner.
<i>Terminal Transition Zone</i>	Terminal Transition Zone is transition zone in which the traffic will be redirected from the deviated path of construction zone to their normal path, which can be achieved through tapering or through circular curves.
<i>Terminal Taper Length (TTL)</i>	The Terminal Taper Length (TTL) is the section of the work zone in which the traffic is redirected to the normal path and the length of the terminal taper will be dependent upon the rate of taper adopted to accomplish this.

<i>Traffic cones</i>	Traffic Cones are the rubber or hard plastic cone having a square base to make them stand independently and used to delineate the traffic paths and also to channelize the traffic movements as required at the work zone. These can be of different color and made with retro-reflective plastic/rubber materials.
<i>Traffic Control Devices</i>	Traffic Control Devices are equipment such as signs, signals, flashers, delineators, markings, barriers used to communicate with the road users and regulate, warn, or guide through the work zone. They are normally placed in/over and adjacent to a street, highway, pedestrian facility, or cycle track by the persons/organizations responsible for managing the traffic operations efficiently and safely.
<i>Traffic Space</i>	The Traffic Space is the portion of the work zone in which road users are routed and channelized through the zone of different activities of construction.
<i>Transverse Bar Marking</i>	Transverse Bar Marking is thermoplastic marking in the form of stripes of width 300-600 mm laid across the carriageway in transverse direction at varied spacing, to alert the drivers about the unusual situation or road work ahead and for speed reduction.
<i>Tubular Markers</i>	Tubular Markers are channelizing devices used effectively to divide opposing lanes of road users, or to delineate the traffic lanes and also to delineate the edge of a pavement where the space limitations do not allow the use of larger devices. These could be reflectorised also for night visibility.
<i>Typical Construction Layouts</i>	Typical Construction Layouts are the commonly occurring/adopted construction scenarios (as included in this document), and would serve as guide in preparing the site specific Work Zone Traffic Management Plans (WTMPs).
<i>Vulnerable Road Users (VRUs)</i>	Vulnerable Road Users (VRUs) in India are generally considered to be the road users in the form of pedestrians, cyclists and two- wheeler riders and other non motorised vehicles, who are more exposed and susceptible to road traffic hazards.
<i>Warning Sign</i>	The Warning Signs are the triangular signs with yellow background and red border used to warn/caution the road users about the presence of work zone. This is in variation with the normal warning sign of IRC:67-2012 where the background sheet is white.
<i>Water-Filled Barricades</i>	Water-Filled Barricades are modular plastic containers of various sizes and shapes, which can be filled with water, and are forgiving type. They are generally made from frangible materials like rubber/plastic and are in shape of crash barrier.

<i>Work Space</i>	The Work Space is that portion or area of the construction zone closed and excluded from the use of road users and set aside for construction workers, equipment, and materials.
<i>Work zone</i>	Work zone is the stretch/area of a road with construction, maintenance or utility work activities. Signs, channelizing devices, barriers, pavement markings, and/or work vehicles typically mark a work zone. A work zone extends from the first warning sign or flashing lights on a vehicle to the end of road work sign or the last traffic control device.
<i>Work Zone Direction Information Sign</i>	Work Zone Direction Information Signs are the signs installed to guide traffic into and through a temporary diversion prepared for the normal traffic on the road, which may be arranged by use of part of the roadway or a temporarily constructed diversion roadway and detour on account of road works.
<i>Work Zone End</i>	The Work Zone End is announced by a sign, and is the point where the last temporary traffic sign is posted to indicate the end of the work zone, and normal operation of traffic resumes from this point.
<i>Work Zone Informatory Sign</i>	Work Zone Informatory Signs are signs used to inform the road users about any facility provided temporarily as part of traffic management plan in and around work zones. Some work zone specific signs shall be rectangular in shape with yellow background and black letters/legends.
<i>Work Zone Signs</i>	Work Zone Signs are basically temporary signs installed in work zones to convey general and specific messages by means of words or symbols and are categorized as regulatory, warning and informative/guide signs.
<i>Work zone Regulatory Signs</i>	The Worksite Regulatory Signs are the specific regulatory and mandatory signs required for temporary traffic management within the limits of work zones in addition to the regulatory signs provided in IRC:67-2012. Some work zone specific signs shall be rectangular in shape with red background and white letters/legends.
<i>Work zone Warning Signs</i>	Worksite Warning Signs are the temporary warning signs used in work zones. These are triangular in shape with yellow background, black legends and red borders and also rectangular in shape with yellow background and black words/legend.

SECTION 3

PRINCIPLES OF WORK ZONE TRAFFIC MANAGEMENT PLANS

3.1 Basic Principles of WTMP

The basic safety principles governing the design of roadways should also govern the design of Work Zones Traffic Management Plans (WTMPs). While designing the WTMP, all care needs to be taken so that anyone coming along the road or the footpath from any direction understands exactly what is happening and what is expected of him/her.

The aim should be to facilitate the passage of road users through such work zones using roadway geometrics, roadside features, and Traffic Control (TC) devices comparable to those for normal highway operations. Thus, road user movement should be free from any hazard with the following aspects in view:

- WTMP at work sites should be designed on the assumption that drivers will only reduce their speeds if they clearly perceive a need to do so. Frequent and abrupt changes in geometrics such as lane narrowing, dropped lanes, or main roadway transitions, that require rapid maneuvers, need to be avoided.
- Provisions should be made for the safe operation of work, particularly on high-speed, high-volume roads.
- Bicyclists and pedestrians, including those with disabilities, should be provided with access and safe passage through the work zones. Bicyclists and pedestrians should be guided in a clear and positive manner while approaching and traversing the work zones.
- Roadway occupancy (i.e. using the roadway for construction activities) should be scheduled during off-peak hours, and if necessary, night work should be considered after carefully assessing its pros and cons.
- Road users and worker safety and accessibility in work zones should be an integral and high-priority element of every project, from planning through design and construction.
- Early coordination with officials having jurisdiction over the affected cross streets, and those providing emergency services, should take place before roadway or side street closings.
- Special plan preparation and coordination with transit, other highway agencies, law enforcement and other emergency units, utilities, schools, and railways are needed for reducing unexpected and unusual road users resistance.
- If the work zone includes a highway-rail at-grade level crossing, early coordination with the railways should take place.

- Special attention may be needed to regulate and control heavy commercial vehicle traffic in the work zones.

3.2 Planning of WTMP

The planning and designing of WTMP should be based on some of the important considerations.

3.2.1 *Provide safety for road users and workers*

Safety provisions governing the design of road works should be followed, and a detailed traffic control and management plan should be developed in consultation with concerned stakeholders. It is important to maintain a continuously safe working environment and also to maintain the work zone safety devices in every phase of the work. This should include using basic safety principles governing the design of permanent roadways, and should consider the needs of all road users (pedestrians, bicyclists, non motorized vehicles, cars and trucks, etc.). In urban areas, particular consideration is necessary for vulnerable road users, as well as the needs of public transport and delivery vehicles and users. It should warn road users in advance of the changing road environment; inform road users of the condition to be encountered; guide road users through unusual sections of road; provide control for road users at conflict points; and forgive road users' mistakes when accidents happen.

3.2.2 *Minimize hindrance or delay to road users*

The traffic control and management plan must assume that drivers will reduce speeds if they perceive a clear need to do so. A WTMP should be designed so that vehicles can reasonably safely travel through the Temporary Traffic Control (TTC) zone with a speed reduction appropriate for the location. However, whatever speed limit is chosen and implemented, it is absolutely imperative that these are enforced. Experience has shown that to be effective and to ensure they do not lose credibility with drivers, there must be a programme of enforcement. Speed cameras are quite effective as they give drivers the opportunity to modify their behaviour even if they speed past the first camera. The key consideration is to have the appropriate speed for the prevailing conditions.

Abrupt, unrecognizable changes to lane position or roadway transition should be avoided, and work should be scheduled to minimize the need for alternate routing. To avoid peak periods – night work, if carefully managed, can be a good way to accomplish this. For optimal safety considerations, diversion of traffic to alternative routes that do not include the work zones be examined and resorted to. On high speed roads, consideration should be given to assess whether it is appropriate to close entrance ramps in a grade separator. Pedestrian and bicyclist movements must be considered.

3.2.3 *Provide clear and positive guidance to road users*

Appropriate warning, delineation, and channelization will ensure that road users have a good understanding of what is happening and what is expected of them–minimizing the chance of errors.

3.2.4 *Ensure roadside safety maintenance*

It is important to make sure that there is a roadside recovery area (clear zone), although difficult to manage in some work zones, particularly for disabled vehicle and emergency situations. Road worker's vehicles and equipment should NOT be stored in this area, and it should not be used for material or debris from the work site.

3.2.5 *Ensure that planners and decision makers have the necessary knowledge*

Only those individuals who are trained in proper safe practices and have an understanding of safe work zone principles should be permitted to plan and design TMPs.

3.2.6 *Provide good public relations*

Traffic enforcement should be considered as part of the planning process, and emergency service providers should be consulted when developing the plan. News media can be of great assistance in these tasks. Road Authorities should plan and set up the system for informing the users regarding planned work zones through print, electronic media and pamphlets. Providing the public with appropriate information about an upcoming work zone, possible alternate transportation means and routes, and expected delays and duration will assist in minimizing the inconvenience to the road users.

3.3 Primary Features of WTMP

The following features of the WTMP should be given adequate attention for achieving maximum safety and efficiency in traffic operations, involving the movement of men and material in work zones.

- Required appropriate warning, delineation, and channelization should be provided to assist in guiding road users in advance of and through the work zone by using proper pavement marking, signing, or other devices that are effective under varying conditions. Providing information that is in usable formats by pedestrians with visual disabilities should also be considered and provided for.
- Provisions for effective continuity of accessible circulation paths for pedestrians should be incorporated in temporary traffic management plan where existing pedestrian routes are blocked or detoured, information should be provided about alternative routes that are usable by pedestrians with disabilities, particularly those who have visual disabilities. Before any new detour or temporary route is opened to traffic, all necessary signs shall be in place.
- Access to temporary bus stops, reasonably safe travel across intersections with accessible pedestrian signals, and other routing issues should be considered where temporary pedestrian routes are channelized. Barriers and channelizing devices that are detectable by people with visual disabilities should be provided.

- Traffic control devices inconsistent with intended travel paths through the work zones should be removed or covered. As the work progresses, temporary traffic controls and/or working conditions should be modified in order to provide reasonably safe and efficient road user movement and to provide worker safety. Providing traffic control devices that are accessible to and usable by pedestrians with disabilities should be considered.
- Flagging procedures, when used, should provide positive guidance to road users traversing the work zone. Procedures of flagging the traffic are separately explained.
- Professionals who are knowledgeable, trained and/or certified in the principles of proper traffic control should be assigned responsibility for safety in work zones. The most important duty of these individuals should be to check that all traffic control devices of the project are reasonably consistent with the traffic management plan and are effective in providing reasonably safe conditions for motorists, bicyclists, pedestrians, and workers.
- Work zones should be carefully monitored under varying conditions of road user behavior, traffic volumes, light, and weather conditions, to check that applicable traffic control devices are effective, clearly visible, clean, and in compliance with the traffic management plan.
- Coordination should be made between adjacent or overlapping projects to check that duplicate signing is not used and to check compatibility of traffic control between adjacent or overlapping projects.
- When warranted, an engineering study should be made in cooperation with law enforcement officials of reported crashes occurring within the traffic control zone. Crash records in traffic control zones should be monitored to identify the need for changes in the work zone.
- To accommodate run-off-the-road incidents, disabled vehicles, or emergency situations, unencumbered roadside recovery areas or clear zones should be provided where practical.
- As part of the WTMP, the Contractor/Concessionaire to keep and maintain crane facilities to tow away any disabled vehicle promptly from the work zone area.
- Work equipment, workers' private vehicles, materials, and debris should be stored in such a manner to reduce the probability of being impacted by run-off-the-road vehicles.
- Only those professionals who are trained in proper traffic control practices and have a basic understanding of the principles, established by applicable standards and guidelines, including those of these guidelines, should supervise the selection, placement, and maintenance of traffic control devices used for work zones.

- All TC devices shall be removed as soon as practical when they are no longer needed. When work is suspended for short periods of time, traffic control devices that are no longer appropriate shall be removed or covered.

3.4 Requirements of Work Zone Traffic Management Plan

A WTMP should describe traffic control measures to be used for facilitating the safe and efficient movement of road users through a work zone. WTMP should play a vital role in providing reasonably safe and efficient road traffic flow for all road users when a work zone temporarily disrupts normal traffic flow.

- WTMPS may range in scope from being very detailed to simply referring to typical drawings contained in these guidelines or specific drawings contained in the contract documents. The degree of detail in the TMPs depends entirely on the nature and complexity of the works to be implemented.
- WTMPS should be prepared by professionals, knowledgeable (for example, trained and/or certified) about the fundamental principles of safety, traffic control measures and work activities to be performed. The design, selection and placement of traffic control devices for a TMP should be based on engineering judgment.
- The planning for traffic control for the work zone should be completed for all highway construction, utility work, maintenance operations, including minor maintenance and utility projects prior to occupying the work zone. Planning for all road users should be included in the process.

3.5 WTMP in Urban Areas

- In urban situations, where road works are to be carried out, more attention should be given to the problems of pedestrians and non-motorized vehicles in places where heavy traffic volumes are involved. As far as possible, the road works should be carried out at night, and whenever night time road repairs are not possible, then only day time repairs should be carried out. Repairs during peak hours should also be avoided.
- Road users should be channelized and routed through and around the area under repair with minimum of delays. Driver behavior should be effectively influenced so that the speeds are reduced to desired levels on approaches to construction zones. The traffic control and construction activity should be coordinated in such a manner as to provide for safe and efficient flow of traffic together with safe, efficient and rapid progress of construction activity.
- As pedestrians are likely to be present at urban construction sites, there must always be safety or buffer zone between the outer pedestrian barrier and the traffic.

- Availability of proper sight distance for the movement of vehicles at the recommended speed for the stretch in the work zone should always be kept in the mind.

3.6 WTMP in Project Development

There are five phases of WTMP for major projects:

- Planning Phase - To identify and include traffic control requirements, work program and method of construction in the contract specification.
 - Design Phase - To design the Traffic Management Plan in detail, with regard to types, location and layout of traffic control devices for submission to the road authority for approval.
 - Implementation Phase - To install the temporary traffic control devices safely in accordance with the approved Traffic Management Plan.
 - Operation and Maintenance Phase - To inspect the Traffic Management Plan and devices regularly both in day and night to ensure that they are effective and absolutely safe.
 - Close out Phase - To remove all the temporary traffic control devices safely and reinstate the permanent traffic control scheme.
-

SECTION 4

TEMPORARY TRAFFIC CONTROL ZONES

4.1 Introduction

A work zone is an area of a highway where road user operating conditions are changed because of construction and maintenance activities. The construction and maintenance activities would involve movement of workers and construction equipment requiring dedicated space for performing the activities and moving materials for the activities. The presence of regular traffic and works traffic makes the work zone a potential zone of conflict resulting in disruption to normal traffic and hazards. A work zone is typically distinguished by the presence of signs, channelizing devices, barriers, pavement markings, and/or work vehicles. It extends from the first warning sign or high-intensity rotating flashing or oscillating or strobe lights installed on roadside or a vehicle-mounted sign posted to indicate the work zone, and continues to delineate the channelized vehicle paths till up to the end road work sign.

4.2 Elements of Temporary Traffic Control Zone

The elements of Temporary Traffic Control Zone are

- Advance warning zone
- Approach transition zone
- Activity zone
- Terminal transition zone
- Work zone end zone

Suggested lengths for Temporary Traffic Control Zone for different speeds are given in **Table 4.1** and illustrated in **Fig. 4.1**. The normal posted speed of the highway shall be the speed at the start of each traffic control zones. For example, the speed at the start of advance warning zone shall be the approach speed of highway and length of the advance warning length shall be chosen based on this approach speed. However, the speed to be considered for taper rate or the radius of circular curve at the diversion shall be dictated by the geometric properties of these elements, as traffic is expected to reduce the speed as they are adequately warned through number of signs.

4.2.1 Advance warning zone

The “Advance Warning Zone” is the area to warn the road user of the approaching hazard and to prepare them for the change in driving conditions. It should provide information on:

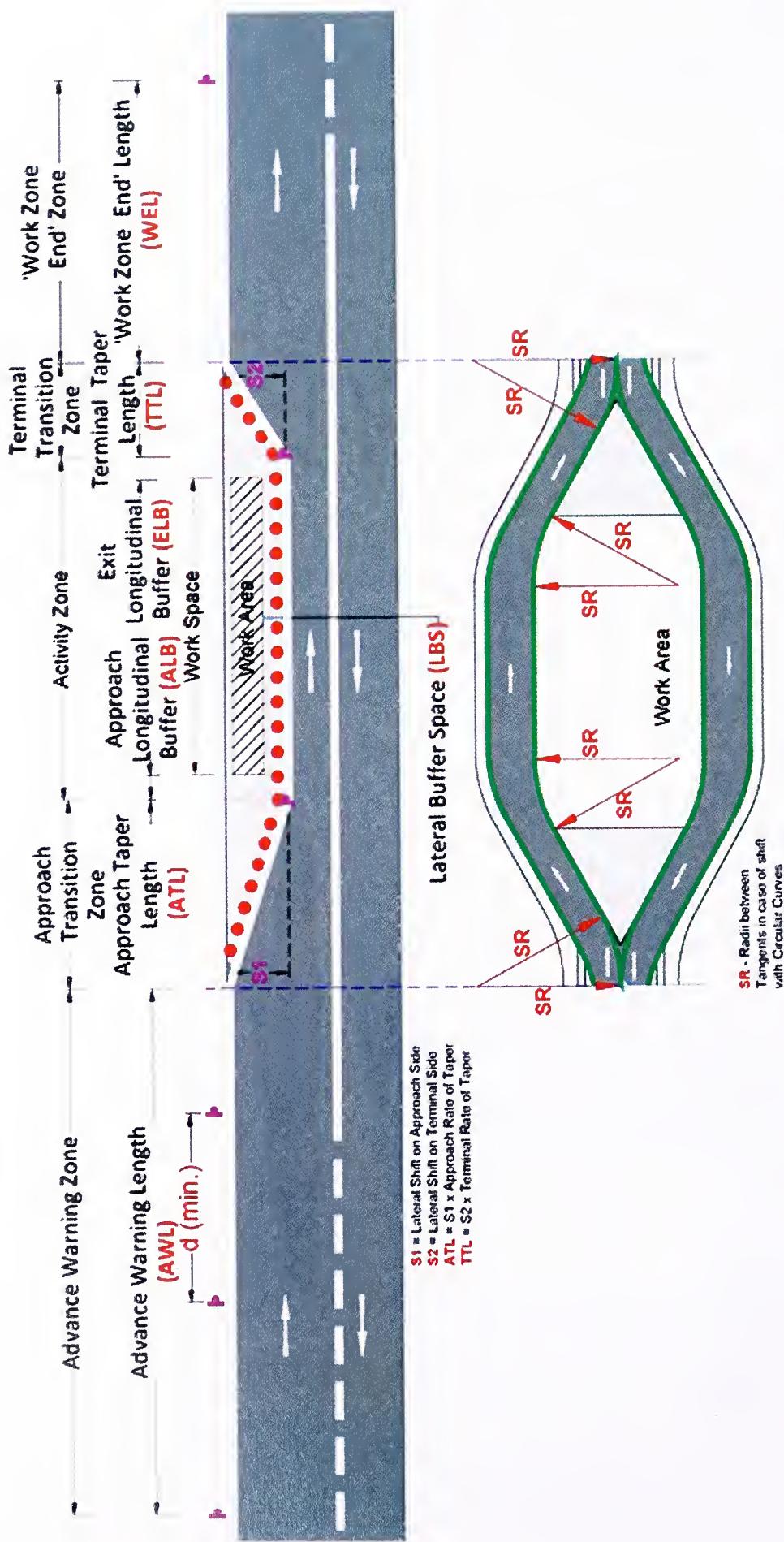
- The presence of the hazard through the “Men at Work” sign, accompanied by the distance to the hazard;
- Any change affecting traffic arrangements (such as a reduction in the number of lanes and/or in the speed limit) within the traffic control zone;

Table 4.1 Suggested Lengths for Temporary Traffic Control Zones

Speed at the Start of Traffic Control Zones (kmph)	Advance Warning Zone/Length	Transition Zone/Length						Work Space	Distance Between Sites in kilometers		
		First Sign from Start of Taper i.e. Advance Warning Length-AWL	Minimum Distance between two successive signs in meters-d (min.)	Approach Taper Length in Meters-ATL	Terminal Taper Length in Meters-TTL	Radius in Case of Circular Curves in meters - SR	'Work Zone End' Length in meters - WEL	Minimum Approach Longitudinal Buffer in meters - ALB	Minimum Exit Longitudinal Buffer in meters - FLB	Minimum Lateral Buffer in meters - LBS	Desirable
Up to 50	180	40	1:12	12	24	48	1:10	10	20	40	30
51 to 65	270	55	1:15	15	30	60	1:12	12	24	48	90
66 to 80	350	80	1:18	18	36	72	1:15	15	30	60	165
81 to 100	500	100	1:20	20	40	80	1:18	18	36	72	250
101 to 120	1100	120	1:25	25	50	100	1:20	20	40	80	400
											Varies**
											2
											1
											5
											2
											10
											5
											10
											5
											10
											10
											5

** The length of work space depends upon the nature of work actually taken up. For example for routine maintenance work, it can be quite small, whereas for major improvement work, it can be upto 5 km.

Note : The recommended length of work zone and distance between two sites given in this Table is based on practice followed in UK
(Refer: Traffic Sign Manual, Chapter 8, 2009, DoT)



Note : The measured distance of S1 and S2 shown above is same when the road section is straight and may differ in other cases.

Fig. 4.1 Temporary Traffic Control Zone/Lengths

- Extent of the hazard (for example; the length of restriction);
- The type of hazard etc.

The advance warning zone is where the reduction in speed of vehicles should be notified. The drivers should be advised to reduce their speed so as to achieve the desired speed of transition zone. The information in this zone is conveyed through a series of traffic signs along the length of the zone. Typical distances for placement of advance warning signs for various approach speeds are also given in **Table 4.1**.

4.2.2 Approach transition zone

The transition zone is that section of highway where road users are redirected from their normal path, where the regular traffic is guided to deviate from their normal path of travel through this zone. Lateral shifting of moving vehicle from the normal pathway can be achieved by strategic use of tapers or with circular curves.

The rate of taper and Approach Taper Length (ATL) for a few sample width are presented in **Table 4.1**, where the speed reduction is expected from the approach speed at the start of taper, and it is illustrated in **Fig. 4.1**. If diversion is achieved through circular curves, the radii of the curves to be inserted between two tangents are also presented in **Table 4.1**, and shown pictorially in **Fig. 4.1**. The values suggested for curve radii will be applicable for layouts of median crossovers. Tapers are created by using a series of channelizing devices and/or pavement markings to move traffic out of or into the normal path.

4.2.3 Activity zone

The activity zone is the section of the highway where the construction activity takes place. It comprises the work space, the traffic space, and the buffer space.

Work Space : The work space is that portion of the highway closed to road users and set aside for workers, equipment, and material. Work spaces are usually delineated for road users by channelizing devices or to exclude vehicles and pedestrians in the work space by temporary barriers. The work space may be stationary or may move as work progresses, and therefore, the length of the work space may vary.

Traffic Space : The traffic space is the portion of the highway in which road users are routed through the activity zone. This space should be determined and designed keeping in mind the traffic expected to move through the activity zone.

Buffer Space : The buffer space is a lateral and/or longitudinal length/width that separates the normal traffic flow from the work space or an unsafe area, and might include some recovery space for an errant vehicle. Neither work activity nor storage of equipment, vehicles, or material should occur within a buffer space. Buffer spaces may be positioned either longitudinally or laterally with respect to the direction of traffic flow. The activity area may contain one or more lateral or longitudinal buffer spaces. A longitudinal buffer space may be placed in advance of a work space. The lateral buffer space may be used to separate the traffic space from the work space, as shown in **Fig. 4.1**, or at such areas as excavations or

pavement-edge drop-offs. A lateral buffer space also may be used between two travel lanes, especially those carrying opposing flows. The minimum values for various passing speed for Approach Longitudinal Buffer, Exit Longitudinal Buffer and Lateral Buffer Space are given in **Table 4.1**. Placing of work zone at closer intervals will always be inconvenient for road users, and hence the desirable distance between two work zones are given in **Table 4.1**, which may be maintained, as far as possible. However, at unavoidable situations, the distances given for exceptional cases can be adopted subject to the approval of competent authority.

4.2.4 *Terminal transition zone*

In the terminal transition zone, the traffic will be redirected from the deviated path to their normal path through the transition zone, which also can be achieved through tapering or through circular curves.

The rate of taper and Terminal Taper Length (TTL) for a few sample width of shift are presented in **Table 4.1**. In the terminal transition, a lower value than the approach transition can be adopted as the traffic plying through a temporary diversion should be already at lower operating speed than on normal approach road. The lateral shifts by tapering and by circular curves are presented in **Fig. 4.1**. Channelizing devices and/or pavement markings should be used to bring traffic back to the normal path.

4.2.5 *Work zone end*

The work zone end length shall extend from the end of terminal taper length to the last traffic control device such as sign showing the end of road work, if posted. An end road work sign, a speed limit sign, or other signs may be used to inform road users that they can resume normal operations.

SECTION 5

TRAFFIC CONTROL DEVICES

5 Types of Devices

Traffic Control (TC) devices include appurtenances such as signs, signals, flashers, delineators, markings, barriers and other devices used to regulate, warn, or guide road users, and normally placed on, over, or adjacent to a street, highway, pedestrian facility, or cycle track by the engineer responsible for managing the traffic operations efficiently and safely in the work zones. All traffic control devices used on street and highway construction, maintenance, utility laying or repair, shall conform to the applicable provisions of these guidelines. Traffic control devices are broadly classified into three categories, and these are discussed in the following subsections.

- Road Signs
- Channelizing Devices
- Lighting Devices & Variable Message Signs

5.1 Road Signs

Work zone signs convey both general and specific messages by means of words or symbols and have the same three categories as in normal highway, viz. (i) regulatory; (ii) warning; and (iii) informative/guide signs.

The construction zones require more signs than that being used for normal highway to convey site conditions. The regulatory sign to be used in temporary traffic management plans are subdivided as Normal Regulatory (NR) sign and Work zone Regulatory (WR) signs. Those regulatory signs adopted directly from IRC:67-2012 are grouped under normal regulatory signs, and those regulatory signs specifically prepared and included in this guideline for traffic management plan for work zones, are grouped under work zone regulatory signs. The colour of normal regulatory signs will be same as that given in IRC:67-2012, whereas the color of work zone regulatory signs shall be of white texts/arrows/borders on red background. The warning signs are also classified as normal warning sign and work zone warning signs. Normal Warning (NW) signs are those taken from IRC:67-2012. In order to retain the familiarity among the road users, the shape of the normal warning signs used in work zone shall be triangular, but in yellow background for better conspicuity and to distinguish that the road users are passing through the work zones. The Warning signs (WW) specifically meant for work zone shall be rectangular shape with black text/legend/border in yellow background. The informative signs shall be either work zone Information Signs (IS) or temporary Direction Signs (DS), and their color schemes shall be black texts/arrows/borders in yellow background. Shape and color of the background plate to be followed for different categories of signs are given in **Fig. 5.1**.

	Category	Colour	Shape	Examples
Regulatory/ Mandatory	Normal Regulatory (NR) Signs	As given in IRC:67-2012	Circular	 
	Work Zone Regulatory (WR) Signs	Red & White	Rectangular	
Warning Sign	Normal Warning (NW) Signs	As given in IRC:67-2012 but in yellow background	Triangular	
	Work Zone Warning (WW) Signs	Black & Yellow	Rectangular	
Informatory Signs	Work Zone Information Signs (IS)	Black & Yellow	Rectangular	
	Work Zone Direction on Signs (DS)	Black & Yellow	Rectangular	

Fig. 5.1 Shape & Color Pattern of Signs In WTMP

5.1.1 *Retro reflective sheeting for road signs*

For all roads works except on access controlled highway, the sheeting for ground mounted signs to be used in WTMPS shall be of CLASS B sheeting, i.e. High Intensity Prismatic grade sheeting as per ASTM D 4956-09 Type III and IV, as given in IRC:67-2012, whereas for access controlled highway it shall be of CLASS C sheeting, i.e. Micro Prismatic grade sheeting as per ASTM D 4956-09 Type VIII and IX as given in IRC:67-2012. For maintenance works during operation stage of National and State Highway having approach speed exceeding 65 kmph, the sheeting can be CLASS C sheeting, i.e. Micro Prismatic grade sheeting as per ASTM D 4956-09 Type VIII and IX.

5.1.2 *Sign placement*

Signs should be located on the left side of the roadway unless otherwise specified in these guidelines. Where special emphasis is needed, signs may be placed both on the left and right sides of the roadway. The height and lateral clearance of temporary ground-mounted signs

are given in **Fig. 5.2** and **Table 5.1**. Ground-mounted signs installed at the side shoulder of the road in rural areas shall be mounted at a height at least 2.1 m measured from the bottom of the sign to the near edge of the pavement.

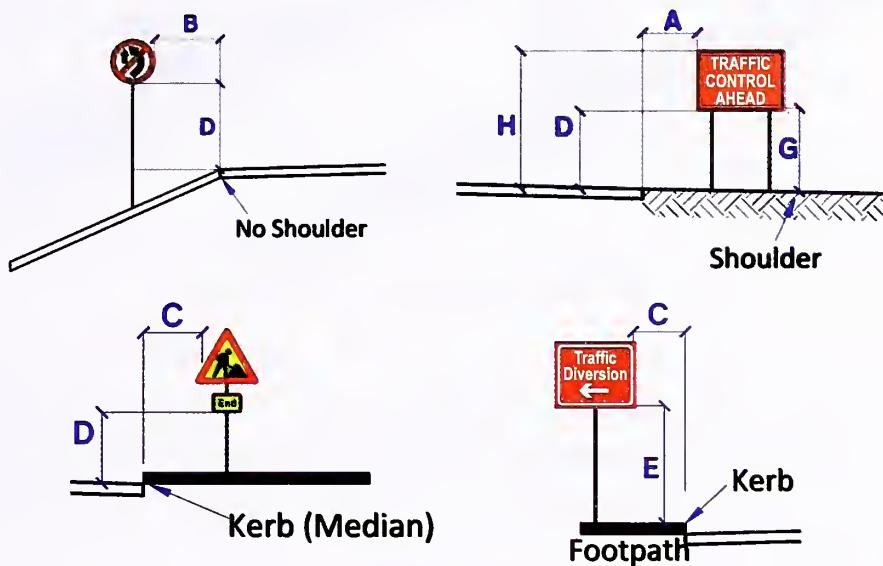


Fig. 5.2 Lateral & Vertical Clearance

Table 5.1 Heights and Clearances of Signs

	Minimum (mm)	Desirable (mm)	Maximum (mm)
A	1200	1800	2500
B	1000	2000	2500
C	300	600	1000
D	1500	1800	2100
E	2100	2100	2500
H	-	-	5000
G	1800	2000	2100

In business, commercial, and residential districts where parking and/or bicycle or pedestrian movement is likely to occur, or where there are other obstructions to view, the distance between the bottom edge of the sign and the top of the near edge of the traveled way shall be at least 2.1 m. Neither portable nor permanent sign supports should be located on footpath, bicycle facilities, or areas designated for pedestrian or bicycle traffic so that no obstruction is caused in their movements.

Signs mounted on portable supports may be placed within the roadway itself. Signs may also be mounted on or above barricades. Typical mounting of signs on barricades is shown in **Fig. 5.3**. The signs mounted on barricades and barricade/sign combinations shall be crash worthy. Signs mounted on barricades, or other portable supports, shall be no less than 0.3 m above the traveled way. Signs mounted on Type III barricades should not cover more than 50 percent of the top two rails or 33 percent of the total area of the three rails.

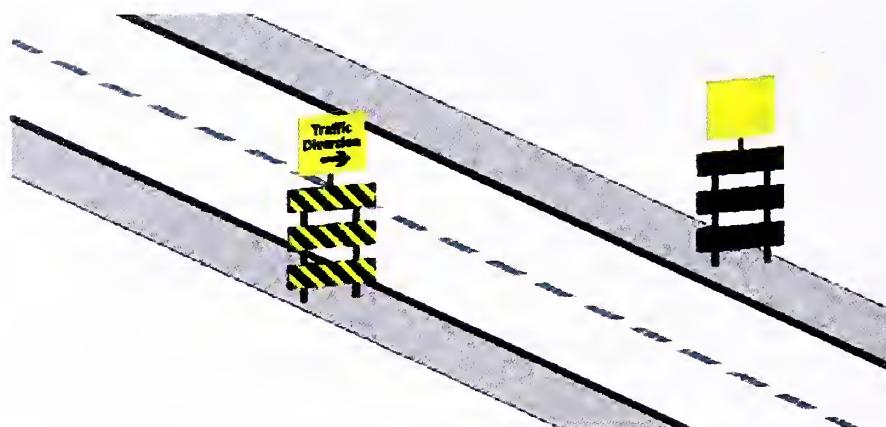


Fig. 5.3 Signs Mounted on Barricades

Large signs having an area exceeding 5 square meters (that are installed on multiple breakaway posts shall be mounted at minimum of 2.1 m above the ground. For mobile operations, a sign may be mounted on a work vehicle, a shadow vehicle, or a trailer stationed in advance of the Temporary Traffic Control (TTC) zone or moving along with it.

5.1.3 *Design of signs*

The design of various signs to be used in work zones like work zone regulatory and warning signs and informative and temporary direction information sign shall be governed by the speed at which the sign is expected to be read by the driver and with the font sizes as given in **Table 5.2**.

Table 5.2 Letter Size

Speed of Operation	"X" Height (mm) Lower Case	"X" Height (mm) Upper Case	Minimum Clear Visibility to the Sign (m)
Up to 50 km/h	75	105	45
51 - 65 km/h	100	140	60
66 - 80 km/h	125	175	75
81 - 120 km/h	150	210	105
101 - 120 km/h	200	280	135

The Annexure III and Plate III of IRC:67-2012 lay the principles for designing various sign boards involving texts in English, Hindi or other regional languages and arrows like the Work Zone Regulatory Signs, Work zone Warning Signs and Information Signs. The sign boards shall be designed for English and Hindi or other regional languages as appropriate for the location.

5.1.4 *Regulatory signs*

The regulatory signs to be used in work zones are subdivided as normal regulatory signs and work zones specific regulatory sign. Regulatory signs are to instruct road users of traffic laws or regulations and to indicate the applicability of legal requirements that would not otherwise be apparent. For ensuring legibility and emphasis at night, the signs shall be retro-reflective

of at least Grade Type III, i.e. high intensity grade conforming to 801 of Specifications for Roads & Bridges, Ministry of Road Transport and Highways. The material shall be smooth, sealed outer surface or illuminated so as to depict the same shape and similar color for both day and night. Sign illumination may be either internal or external and the sign boards may be made of rigid or flexible material.

If a Temporary Traffic Control (TTC) zone requires regulatory measures different from those existing, the existing permanent regulatory devices shall be removed or covered and superseded by the appropriate temporary regulatory signs. This change shall be made in conformity with applicable ordinances or statutory order of the local jurisdiction. It is essential, therefore, that they are used only after consulting the local police and traffic authorities.

5.1.4.1 *Normal regulatory signs*

The Normal regulatory signs are the circular signs as prescribed in IRC:67-2012 and similarly the color and shape pattern shall be the same as given in IRC:67-2012. The speed of the road governs the size of the signs and they vary from 600 mm to 1200 mm as given in **Table 5.3**. The 'STOP' and 'GIVE WAY' signs are the exceptions, where the height of an octagonal 'STOP' sign shall be 750 mm, 900 mm, and 1200 mm respectively for an approach speed of up to 50 kmph, 51 to 65 kmph and greater than 65 kmph. In the case of 'GIVEWAY' sign, the one side shall be 600 mm, 900 mm, 1200 mm respectively for approach speed up to 50 kmph, 51 to 80 kmph and greater than 80 kmph. The applications of normal regulatory signs are presented in **Fig. 5.4** with brief description about the usage of sign.

Table 5.3 Size of Circular Signs

Speed	Size	Diameter of Circle (mm)
Upto 65 kmph	Small	600
66 - 80 kmph	Medium	750
81 - 100 kmph	Normal	900
> 100 kmph	Large	1200

Fig. 5.4 Application of Normal Regulatory Signs

Stop sign is used in road works as per temporary traffic management plan where traffic is required to stop and that the vehicle shall proceed past the stop line only after ascertaining that this will not cause danger.



Fig. WZ.NR01

The GIVE WAY sign is used to assign right-of-way to the vehicles controlled by the sign must give way i.e. yield to other traffic having the right of way due to road works. Vehicles controlled by this sign need to slow down or stop when necessary to avoid interfering with conflicting traffic.



Fig. WZ.NR02

Fig. 5.4 Application of Normal Regulatory Signs (Continued)

The sign shall be located at the entry to the one-way street due to detour or traffic diversion plan



Fig. WZ.NR03

This sign will be where a side road forms a T-junction with a two-way road and traffic is required to turn in one direction due to road works



Fig. WZ.NR05

The sign shall be erected to prohibit overtaking in approach warning zone. It can be placed both sides and can be repeated for emphasis



Fig. WZ.NR07

The sign shall be erected to prohibit parking on account of road works



Fig. WZ.NR09

The "No Parking" sign is used on the roads to prevent any parking of vehicles on the main carriageway which will lead to congestion



Fig. WZ.NR11

The signs shall be located at road section where the vehicles are not allowed to enter on account of Work zone traffic management plan



Fig. WZ.NR04

This sign will be where a side road forms a T-junction with a two-way road and traffic is required to turn in one direction due to road works



Fig. WZ.NR06

The sign shall be used to indicate that drivers must give way to oncoming vehicles. If necessary a definition plate can be installed below the sign written 'Give way to oncoming vehicles'. Definition plate can be written either in English or Hindi or in regional language as appropriate



Fig. WZ.NR08

The sign shall be erected to prohibit parking, waiting and standing on account of road works



Fig. WZ.NR10

The sign shall be erected where entry is prohibited for vehicles whose axle load exceeds a particular limit in a temporary road or a structure for construction



Fig. WZ.NR12

Fig. 5.4 Application of Normal Regulatory Signs (Continued)

The sign shall be erected in advance of an overhead structure where entry height has been restricted due to road works



Fig. WZ.NR13

The sign shall be erected where entry is prohibited for vehicles whose laden weight exceeds the indicated limit as the temporal road or structure cannot afford the weight beyond that indicated



Fig. WZ.NR15

The sign to indicate the diversion that are lawfully to be taken on account of work zone management plan and the traffic to move in the Ahead direction



Fig. WZ.NR17

The sign to indicate the diversion that are lawfully to be taken on account of work zone management plan and traffic to move ahead and left direction



Fig. WZ.NR19

The signs indicate the diversions that are lawfully be taken and direction of movement with respect to the position of sign installed and traffic to move in right direction.



Fig. WZ.NR21

The sign is for the diversion that are lawfully be taken in advance approximately 50 m ahead due to temporary traffic management plan



Fig. WZ.NR23

The sign shall be erected where entry of vehicles exceeding a particular length is prohibited on account of construction activities



Fig. WZ.NR14

The sign shall be located in advance warning zone to prescribe the speed limit and warrants reduction in the speed on approaches. It can be repeated with a lower value at the start of taper and also in the diverted pathway



Fig. WZ.NR16

The sign to indicate the diversion that are lawfully to be taken on account of work zone management plan and traffic to move ahead and right direction



Fig. WZ.NR18

The signs indicate the diversions that are lawfully be taken and direction of movement with respect to the position of sign installed and traffic to move in left direction



Fig. WZ.NR20

The diversions that are lawfully be taken in advance approximately 50 m ahead due to temporary traffic management plan



Fig. WZ.NR22

The sign shows keep left of sign placed due to road works traffic diversion.



Fig. WZ.NR24

Fig. 5.4 Application of Normal Regulatory Signs (Continued)

The sign shows keep right of sign placed due to road works traffic diversion



Fig. WZ.NR25

The sign shows vehicle can pass either side due to road works traffic diversion



Fig. WZ.NR26

The sign shall mean that only pedestrians are allowed and the traffic is not allowed on this portion of street due to temporary traffic management



Fig. WZ.NR27

This sign shall indicate the point at which all prohibitions imposed upon traffic due to road works traffic management ceases to apply



Fig. WZ.NR28

5.1.4.2 Work zone regulatory signs

As mentioned earlier, the regulatory/mandatory signs required for temporary traffic management in addition to regulatory signs that are to be adopted from IRC:67-2012 are grouped under work zone regulatory signs. These are to be installed for WTMP either to regulate or to control. The design of work zone regulatory sign shall be done for speed and font size as given in Section 5.1.3. Wherever required sign boards are to be designed and installed in Hindi or in other regional languages. The application of different work zone regulatory signs is presented in Fig. 5.5.

Fig. 5.5 Application of Work Zone Regulatory Signs

Sign is to indicate that road ahead has been closed as part of temporary traffic management plan



Fig. WZ.WR01

The sign to be installed where a pathway or opening is kept for entry of works traffic only and all other traffic has to follow the WTMP provided for them



Fig. WZ.WR02

Fig. 5.5 Application of Work Zone Regulatory Signs (Continued)

The sign is installed so that approaching traffic shall realize that the road that kept apparently opened is wrong way for them on account of temporary diversion and traffic shall not enter into it



Fig. WZ.WR03

The sign shall be located at the very point where the traffic shall be deflected to a diverted pathway. The arrow shall be right if the deflection is to the right of approach direction. The sign shall be positioned in such a way that head beam from an approach vehicle will directly collide with the sign for better visibility



Fig. WZ.WR05

The sign to be used in alternate one way movement through portable traffic signal wherein traffic has to wait when red light blows



Fig. WZ.WR07

Sign for traffic diversion at the very location where the sign is installed. It shall be positioned in such a way that signs falls in the funnel of the head beam from an approaching vehicle



Fig. WZ.WR09

It is mandatorily to inform that traffic control exists ahead through any of the methods of alternate one way movement



Fig. WZ.WR04

The sign shall be located at the very point where the traffic has to take a sharp deflection in its movement direction. The arrow shall be reversed if the deflection is to the right of approach direction. The sign shall be positioned in such a way that head beam from an approach vehicle will directly collide with the sign for better visibility



Fig. WZ.WR06

The sign to be used in alternate one way movement with STOP & GO control where traffic has to wait when STOP board is shown for them



Fig. WZ.WR08

Sign to indicate the one way movement to direction to which arrow is shown. The arrow direction be reversed if it is to the right of approach direction. It shall be positioned in such a way that signs falls in the funnel of the head beam from an approaching vehicle



Fig. WZ.WR10

Fig. 5.5 Application of Work Zone Regulatory Signs (Continued)

Sign to indicate that road has been closed for through traffic. However, local or residential traffic can go up to a point, beyond which it will be totally blocked



Fig. WZ.WR11

Sign to indicate that road has been closed for all traffic due to temporary traffic management plan



Fig. WZ.WR12

Sign to indicate that exit has been closed for all traffic



Fig. WZ.WR13

Sign to permit exit only



Fig. WZ.WR14

The “STOP” board in STOP and GO control in a one lane-two directional traffic control. The sign shall not be used at night unless the signs are directly illuminated. When a frame is used to support the sign, it shall be circular, not octagonal as sign is mounted on circular substrate



Fig. WZ.WR15

The “GO” board in STOP and GO traffic control in work zone in a one lane two directional traffic control. The illumination of both in STOP and GO boards shall be uniform across the sign face and neither partial nor intermittent illumination is permitted



Fig. WZ.WR16

The “SLOW” board to slow down the traffic



Fig. WZ.WR17

The overall size of work zone regulatory signs for different speeds are given in **Table 5.4** and also can be determined following design principles given in **Annexure III** and Plate III of IRC:67-2012.

Table 5.4 Overall Size of Work Zone Regulatory Signs (Length x Height in mm)

Figure No	Upto 50 kmph		51 to 65 kmph		66 to 80 kmph		81 to 100 kmph	
	English	Hindi	English	Hindi	English	Hindi	English	Hindi
Fig. WZ.WR01	585 × 465	425 × 465	780 × 619	566 × 619	975 × 774	708 × 774	1170 × 929	849 × 929
Fig. WZ.WR02	597 × 463	717 × 465	795 × 617	956 × 619	994 × 771	1195 × 774	1193 × 926	1434 × 929
Fig. WZ.WR03	589 × 368	451 × 368	785 × 490	601 × 490	982 × 613	752 × 613	1178 × 735	902 × 735
Fig. WZ.WR04	664 × 465	610 × 465	885 × 619	813 × 619	1107 × 774	1017 × 774	1328 × 929	1220 × 929
Fig. WZ.WR05	1070 × 430 (Chevron)							
Fig. WZ.WR06	1600 × 430 (Chevron)							
Fig. WZ.WR07	906 × 465	795 × 465	1208 × 619	1059 × 619	1510 × 774	1324 × 774	1812 × 929	1589 × 929
Fig. WZ.WR08	861 × 465	795 × 465	1148 × 619	1059 × 619	1435 × 774	1324 × 774	1722 × 929	1589 × 929
Fig. WZ.WR09	543 × 440	470 × 482	723 × 586	626 × 643	904 × 733	783 × 803	1085 × 879	939 × 964
Fig. WZ.WR10	323 × 440	375 × 482	430 × 586	500 × 643	538 × 733	625 × 803	645 × 879	750 × 964
Fig. WZ.WR11	739 × 424	933 × 424	985 × 565	1244 × 565	1232 × 706	1555 × 706	1478 × 848	1866 × 848
Fig. WZ.WR12	435 × 308	458 × 308	579 × 410	610 × 436	724 × 513	763 × 545	869 × 615	915 × 654
Fig. WZ.WR13	537 × 327	477 × 327	716 × 436	635 × 436	895 × 545	794 × 545	1074 × 654	953 × 654
Fig. WZ.WR14	417 × 327	477 × 327	556 × 436	635 × 436	695 × 545	794 × 545	834 × 654	953 × 654
Fig. WZ.WR15	600 (Octagonal)		750 (Octagonal)		900 (Octagonal)		1200 (Octagonal)	
Fig. WZ.WR16	600 (Circular)		750 (Circular)		900 (Circular)		1200 (Circular)	
Fig. WZ.WR17	600 (Circular)		750 (Circular)		900 (Circular)		1200 (Circular)	

5.1.5 Warning signs

The warning signs in work zone are classified into two categories namely normal triangular warning signs and work zone specific warning signs.

5.1.5.1 Normal warning sign

The triangular warning sign when used for work zones shall be on yellow background in order to highlight the hazardous situation in work zone. The size shall be governed by the speed as given in **Table 5.5**. The application of normal warning signs is explained in **Fig. 5.6**.

Table 5.5 Size of Normal Warning Sign

Speed	Size	Side (mm)	Border (mm)	Clear Visibility Distance (m)
Upto 50 kmph	Small	600	45	45
51 - 65 kmph	Medium	750	60	60
66 - 80 kmph	Normal	900	70	60
> 80 kmph	Large	1200	90	90

Fig. 5.6 Application of Normal Warning Sign

Fig. WZ.NW01 Sign to indicate change of direction to left in a work zone



Fig. WZ.NW01

Fig. WZ.NW02 Sign to indicate change of direction to right in a work zone



Fig. WZ.NW02

Fig. WZ.NW03 Sign in case of a reverse bend where first is right turn in a work zone



Fig. WZ.NW03

Fig. WZ.NW04 Sign in case of a reverse bend, where first bend is a left turn in a work zone



Fig. WZ.NW04

Fig. WZ.NW05 Sign to indicate a traffic control in an alternate one way movement ahead through a portal signal.



Fig. WZ.NW05

Fig. WZ.NW06 Sign to traffic from left is merging as part of temporary traffic management plan



Fig. WZ.NW06

Fig. WZ.NW07 Sign to traffic from right is merging as part of temporary traffic management plan



Fig. WZ.NW07

Fig. WZ.NW08 Sign to indicate road suddenly narrows due to road construction



Fig. WZ.NW08

Fig. WZ.NW09 Sign to indicate to pavement width widens ahead in a temporary traffic control zone



Fig. WZ.NW09

Fig. WZ.NW10 Sign to indicate narrow bridge ahead where the width of carriageway is less than the normal width of carriageway in work area



Fig. WZ.NW10

Fig. WZ.NW11 Sign to indicate to steep ascent more than 10% in a traffic control zone



Fig. WZ.NW11

Fig. WZ.NW12 Sign to indicate to steep descent more than 10% in a traffic control zone



Fig. WZ.NW12

Fig. 5.6 Application of Normal Warning Sign (Continued)

Fig. WZ.NW13 Sign to indicate that left traffic lane tapers due to construction work



Fig. WZ.NW13

Fig. WZ.NW14 Sign to indicate that right traffic lane tapers due to construction work



Fig. WZ.NW14

Fig. WZ.NW15 Sign to indicate road becomes dual carriageway in a work zone



Fig. WZ.NW15

Fig. WZ.NW16 Sign to indicate road becomes undivided carriageway in a work zone



Fig. WZ.NW16

Fig. WZ.NW17 Sign to warn that pedestrians are crossing in work zone



Fig. WZ.NW17

Fig. WZ.NW18 Sign to warn that school in work zone area



Fig. WZ.NW18

Fig. WZ.NW19 Sign to warn that two way movement is ahead as part of WTMP



Fig. WZ.NW19

Fig. WZ.NW20 Sign to warn that one (right) lane closure out of two lanes



Fig. WZ.NW20

Fig. WZ.NW21 Sign to warn that one (right most) lane closure out of three lanes



Fig. WZ.NW21

Fig. WZ.NW22 Sign to warn that one (right most) lane closure out of four lanes



Fig. WZ.NW22

Fig. WZ.NW23 Sign to warn that traffic has to be shifted to other carriageway due to WTMP



Fig. WZ.NW23

Fig. WZ.NW24 sign should be displayed when men or machines are working on the road or adjacent to it. The sign with supplementary plate "END" shall be provided at the leaving side of the work zone where traffic revert back to normal flow



Fig. WZ.NW24

Fig. 5.6 Application of Normal Warning Sign (Continued)

Fig. WZ.NW25 Sign to warn that sudden dip in road profile to road work area



Fig. WZ.NW25

Fig. WZ.NW26 Sign to warn speed reduction hump ahead due to work zones



Fig. WZ.NW26

Fig. WZ.NW27 Sign to warn speed reduction with rumble strip due to work zones



Fig. WZ.NW27

Fig. WZ.NW28 Sign to warn about rough road in a temporary traffic control zone



Fig. WZ.NW28

Fig. WZ.NW29 Sign to warn about rough road in temporary traffic control zone



Fig. WZ.NW29

Fig. WZ.NW30 Sign to warn about loose gravel may be thrown due to traffic movement in road works



Fig. WZ.NW30

Fig. WZ.NW31 Sign to warn road is slippery due to road works



Fig. WZ.NW31

Fig. WZ.NW32 to indicate Single Chevron in a temporary diversion



Fig. WZ.NW32

Fig. WZ.NW33 to indicate that stop and go traffic control established using Flagman in an alternate one movement as part of WTMP



Fig. WZ.NW33

5.1.5.2 Work zone warning signs

In addition to normal warning sign prescribed in IRC:67-2012, the warning signs for traffic management are grouped under work zone warning signs. They shall be in black arrows/border/text in yellow background. The applications of work zone warning signs are given in Fig. 5.7.

Fig 5.7 Application of Work Zone Warning Signs



Fig. WZ.WW01 to indicate the road works progresses ahead and sign is installed in the advance warning area

Fig. WZ.WW01



Fig. WZ.WW02 to indicate the temporary traffic diversion and can be installed in the advance warning area

Fig. WZ.WW02

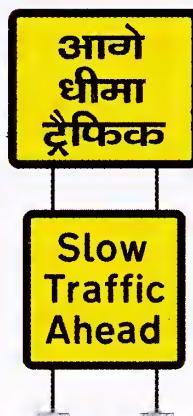


Fig. WZ.WW03 to indicate slow traffic ahead due to road works and can be installed in advance warning area

Fig. WZ.WW03



Fig. WZ.WW04 to inform of one lane road due to traffic control and can be installed at advance warning area

Fig. WZ.WW04



Fig. WZ.WW05 to inform the closure of road at 500 m ahead

Fig. WZ.WW05



Fig. WZ.WW06 to inform the Detour of traffic at 300 m ahead

Fig. WZ.WW06

Fig 5.7 Application of Work Zone Warning Signs (Continued)



Fig. WZ.WW07 to warn of blasting zone at 500 m ahead



Fig. WZ.WW08 to inform of roadwork for the next 5 km or so

Fig. WZ.WW07



Fig. WZ.WW09 as supplementary plate and shall be always with a warning sign to inform that a particular situation depicted in the warning sign exists at 500 m ahead

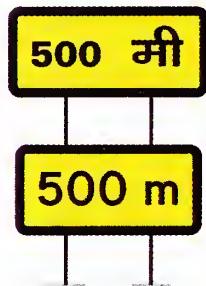


Fig. WZ.WW09

Fig. WZ.WW10 as supplementary plate and shall be always with a warning sign to inform that a particular situation depicted in the warning sign exists at 1 km ahead

Fig. WZ.WW10

Fig. WZ.WW11 to inform that at 10 km ahead through road has been closed and local traffic only is permitted to move forward



Fig. WZ.WW11

Fig. WZ.WW12 to inform that at 10 km ahead the bridge has been closed and local traffic only is permitted to move forward



Fig. WZ.WW12

Fig. WZ.WW13 to inform roadwork ends at the end of traffic control zones



Fig. WZ.WW13

Fig. WZ.WW14 as supplementary plate of inform the particular hazardous situation shown previously ceases to exist. The supplementary plate shall be installed along with warning sign on the same post

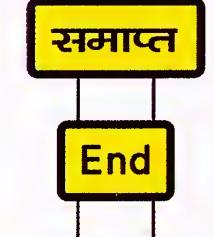


Fig. WZ.WW14

Fig. WZ.WW15 to inform the through traffic that construction vehicles are likely to exit from the work zone in order join the main stream and be cautious



Fig. WZ.WW15

The overall size of work zone warning signs for different speeds are given in **Table 5.6** and also can be done following design principles given in **Annexure III** and Plate III of **IRC:67-2012**.

Table 5.6 Overall Size of Work Zone Warning Signs (Length × Height in mm)

Figure No.	Upto 50 kmph		51 to 65 kmph		66 to 80 kmph		81 to 100 kmph	
	English	Hindi	English	Hindi	English	Hindi	English	Hindi
Fig WZ.WW01	402 × 424	445 × 424	536 × 565	593 × 565	670 × 706	741 × 706	804 × 848	890 × 848
Fig WZ.WW02	613 × 440	510 × 424	817 × 586	679 × 565	1021 × 732	849 × 706	1225 × 879	1018 × 847
Fig WZ.WW03	431 × 424	509 × 423	575 × 565	679 × 565	719 × 706	849 × 706	862 × 847	1018 × 847
Fig WZ.WW04	686 × 307	706 × 327	915 × 410	442 × 436	1144 × 512	1177 × 545	1372 × 615	1413 × 654
Fig WZ.WW05	450 × 424	446 × 424	599 × 565	621 × 565	749 × 706	776 × 746	898 × 847	931 × 847
Fig WZ.WW06	448 × 327	804 × 327	598 × 436	1072 × 436	747 × 544	1340 × 545	897 × 654	1608 × 645
Fig WZ.WW07	506 × 424	552 × 424	675 × 565	736 × 565	844 × 706	920 × 706	1012 × 847	1104 × 847
Fig WZ.WW08	644 × 307	888 × 327	859 × 410	1185 × 436	1074 × 512	1481 × 544	1288 × 615	1777 × 654
Fig WZ.WW09	440 × 214	473 × 214	587 × 284	631 × 285	734 × 356	789 × 356	880 × 427	946 × 427
Fig WZ.WW10	336 × 214	473 × 214	448 × 285	631 × 285	560 × 356	789 × 356	627 × 427	946 × 427
Fig WZ.WW11	991 × 424	1340 × 424	1321 × 565	1786 × 565	1651 × 706	2232 × 706	1981 × 847	2679 × 847
Fig WZ.WW12	991 × 424	1340 × 424	1321 × 565	1786 × 565	1651 × 706	2232 × 706	1981 × 847	2679 × 847
Fig WZ.WW13	644 × 307	778 × 327	859 × 410	1038 × 436	1074 × 512	1297 × 545	1288 × 615	1557 × 654
Fig WZ.WW14	313 × 214	473 × 214	417 × 285	631 × 285	421 × 356	789 × 356	625 × 427	946 × 427
Fig WZ.WW15	549 × 424	494 × 427	732 × 565	659 × 569	915 × 706	824 × 711	1098 × 848	989 × 854

5.1.6 *Informatory signs*

The informatory signs for traffic management plans at work zone are also subdivided into Work zone informative sign and Work zone direction signs for diversion/detour.

5.1.6.1 *Work zone informative sign*

The information signs will serve the road users about a facility prepared either permanently or temporarily as part of traffic management plan at work zones. It may serve for vehicular traffic, pedestrians and cyclist. The sign shall be rectangular in shape with white symbols/letters in yellow background. The work zone informative signs are also to be designed as per Section 5.1.3. The application of informative sign is presented **Fig. 5.8**.

Fig. 5.8 Work Zone Informatory Sign

Fig. WZ.IS01 to indicate the footpath for pedestrian to walk.



Fig. WZ.IS01

Fig. WZ.IS02 to warn that footpath has been closed due to roadwork.



Fig. WZ.IS02

Fig. 5.8 Work Zone Informatory Sign(Continued)

Fig. WZ.IS03 to inform that footpath has been closed and they may use the sides the arrow leading to



Fig. WZ.IS03

Fig. WZ.IS04 to inform that footpath has been closed and the pedestrian to cross as indicated by the arrow. The arrow can be reversed also.



Fig. WZ.IS04

Fig. WZ.IS05 to inform the pedestrians to proceed the arrow leading to



Fig. WZ.IS05

Fig. WZ.IS06 to inform of cycle track and for a facility for cyclist to avail



Fig. WZ.IS06

Fig. WZ.IS07 is to inform that priority has been given to forward movement and traffic in opposite direction is expected to yield. A definition plate can be installed written 'Priority over oncoming vehicles'



Fig. WZ.IS07

The overall size of informative sign in work zones for different speeds are given in **Table 5.7** and also can be determined following design principles given in Annexure III and Plate III of IRC:67-2012.

Table 5.7 Overall Size of Facility Information Signs (Length × Height in mm)

Figure No.	Upto 50 kmph		51 to 65 kmph		66 to 80 kmph		81 to 100 kmph	
	English	Hindi	English	Hindi	English	Hindi	English	Hindi
Fig WZ.IS01	564 × 219	499 × 206	751 × 292	665 × 274	939 × 365	832 × 343	1127 × 438	998 × 411
Fig WZ.IS02	559 × 327	510 × 327	745 × 436	679 × 436	932 × 545	849 × 545	1118 × 654	1019 × 654
Fig WZ.IS03	934 × 424	1227 × 424	1245 × 565	1636 × 565	1557 × 706	2045 × 706	1868 × 848	2454 × 848
Fig WZ.IS04	934 × 424	1000 × 424	1245 × 565	1333 × 565	1557 × 706	1667 × 706	1868 × 848	2000 × 848
Fig WZ.IS05	608 × 337	561 × 350	811 × 449	748 × 466	1014 × 561	935 × 583	541 × 674	1122 × 699
Fig WZ.IS06	385 × 327	575 × 327	513 × 436	766 × 436	642 × 545	958 × 545	770 × 654	1149 × 654
Fig WZ.IS07					600 × 800			

5.1.6.2 Work zone direction information sign

The direction information sign for temporary diversion and detour are also required to be designed and the design principles in Section 5.3 shall be followed. The shape of direction information sign for temporary traffic management plan shall be rectangular and color shall be black border/arrows/text in yellow background. The application for direction information signs for diversion and detours are given in **Fig. 5.9**.

Fig. 5.9 Direction Information for Diversion

Fig. WZ.DS01 to inform approaching traffic to take a detour due to temporary traffic diversion plan



Fig. WZ.DS01

Fig. WZ.DS02 to inform of end of detour.



Fig. WZ.DS02

Fig. WZ.DS03 to inform of cyclist to take a detour due to road works



Fig. WZ.DS03

Fig. WZ.DS04 to inform of pedestrians to take a detour due to road works



Fig. WZ.DS04

Fig. WZ.DS05 to inform to take a detour at the location where the sign is placed.



Fig. WZ.DS05

Fig. WZ.DS06 is a direction information that traffic bound to destination shown here may take the direction shown, as part of traffic detour.



Fig. WZ.DS06

The overall size of direction information sign for detours and diversions are presented in **Table 5.8** and also can be determined following the design principles given in Annexure III and Plate III of IRC:67-2012.

Table 5.8 Overall Size of Direction Information Signs (Length x Height in mm)

Figure No.	Upto 50 kmph		51 to 65 kmph		66 to 80 kmph		81 to 100 kmph	
	English	Hindi	English	Hindi	English	Hindi	English	Hindi
Fig. WZ.DS01	575 × 214	790 × 214	767 × 285	154 × 285	959 × 356	1317 × 356	1150 × 427	1581 × 427
Fig. WZ.DS02	548 × 327	476 × 327	731 × 436	633 × 436	914 × 545	794 × 545	1096 × 654	952 × 654
Fig. WZ.DS03	538 × 439	808 × 424	717 × 586	1078 × 565	896 × 732	1347 × 706	1075 × 879	1917 × 847
Fig. WZ.DS04	538 × 439	808 × 424	717 × 586	1078 × 565	896 × 732	1347 × 706	1075 × 879	1617 × 847
Fig. WZ.DS05	161 × 539	161 × 539	1282 × 719	1282 × 719	1602 × 899	1602 × 899	1923 × 1078	1923 × 1078
Fig. WZ.DS06	As per actual design							

5.2 Channelizing Devices

The function of channelizing devices is to warn and channelize the movement of road users through changed path of movement due to the conditions created by work activities in or near the roadway. Channelizing devices include cones, tubular markers, vertical panels, drums, barricades, pavement markings and road studs.

Channelizing devices provide and facilitate smooth and gradual vehicular traffic flow from one lane to another, onto a bypass or detour, or into a narrower traveled way. They are also used to separate vehicular traffic from the work space, pavement drop-offs, pedestrian or shared-use paths, or opposing directions of vehicular traffic. Devices used to channelize pedestrians shall be detectable to road users and visible to persons having low vision.

Where barricades are used to channelize pedestrians, there shall be continuous detectable bottom and top rails with no gaps between individual barricades. The bottom of the bottom rail shall be no higher than 150 mm above the ground surface, and the top of the top rail shall be no lower than 900 mm above the ground surface. If drums, cones, or tubular markers are normally used to channelize pedestrians, they shall be located such that there are no gaps between the bases of the devices, in order to create a continuous bottom.

Channelizing devices should be constructed and ballasted to perform in a predictable manner when inadvertently struck by a vehicle. Channelizing devices should be crash worthy. Fragments or other debris from the device or the ballast should not pose any significant hazard to road users or workers.

The retro-reflective material used on channelizing devices shall have a smooth, sealed outer surface that will display a similar color in day or night. Particular attention should be paid to maintaining the channelizing devices to keep them clean, visible, and properly positioned at all times. Devices that are damaged or have lost a significant amount of their retro-reflectivity and effectiveness shall be replaced.

5.2.1 Traffic cones

Traffic cones may be of the height of 500 mm, 750 mm and 1000 mm and of 300 to 500 mm in diameter or in a square shape. They shall be of brilliant red/orange/yellow and shall be made of a material that can be struck without causing damage to the impacting vehicle. **Fig. 5.10** shows the traffic cones of 500 mm, 750 mm and 1000 mm.

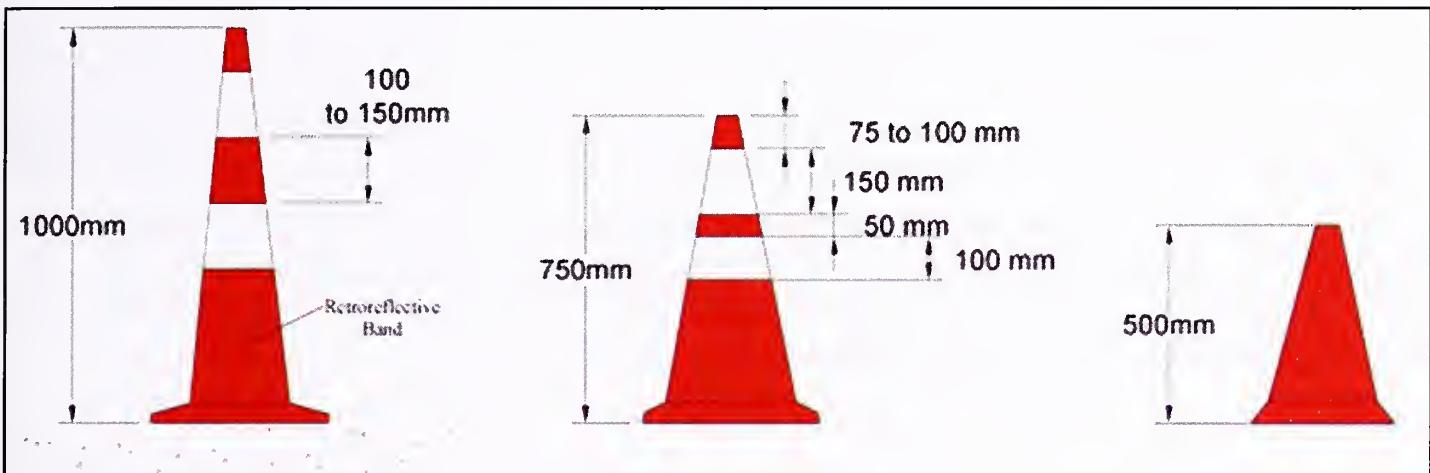


Fig. 5.10 Traffic Cones

For nighttime use, cones shall be retro-reflectorized or equipped with lighting devices for maximum visibility. Retro-reflectorization of cones that are 750 to 1000 mm in height shall be provided by a 150 mm wide white band located 75 to 100 mm from the top of the cone and an additional 100 mm wide white band located approximately 50 mm below the 150 mm band. Retro-reflectorization of cones that are more than 900 mm in height shall be provided by horizontal, circumferential, alternating red and white retro-reflective stripes that are 100 to 150 mm wide. Each cone shall have a minimum of two red and two white stripes with the top stripe being red. Any non-retro-reflective spaces between the red and white stripes shall not exceed 75 mm in width.

Traffic cones may be used to channelize road users, divide opposing vehicular traffic lanes, divide lanes when two or more lanes are kept open in the same direction, and delineate short duration maintenance and utility work.

Steps should be taken to minimize the possibility of cones being blown over or displaced by wind or moving vehicular traffic.

Cones should not be used for pedestrian channelization or as pedestrian barriers in work zones on or along footpath unless they are continuous between individual devices.

Cones may be doubled up to increase their weight. Some cones are constructed with bases that can be filled with ballast. Others have specially weighted bases, or weight such as sandbag rings that can be dropped over the cones and onto the base to provide added stability. Ballast should be kept to the minimum amount needed. The application of traffic cones for roadways with various speeds are presented in **Table 5.9**.

Table 5.9 Application of Traffic Cones (Spacing)

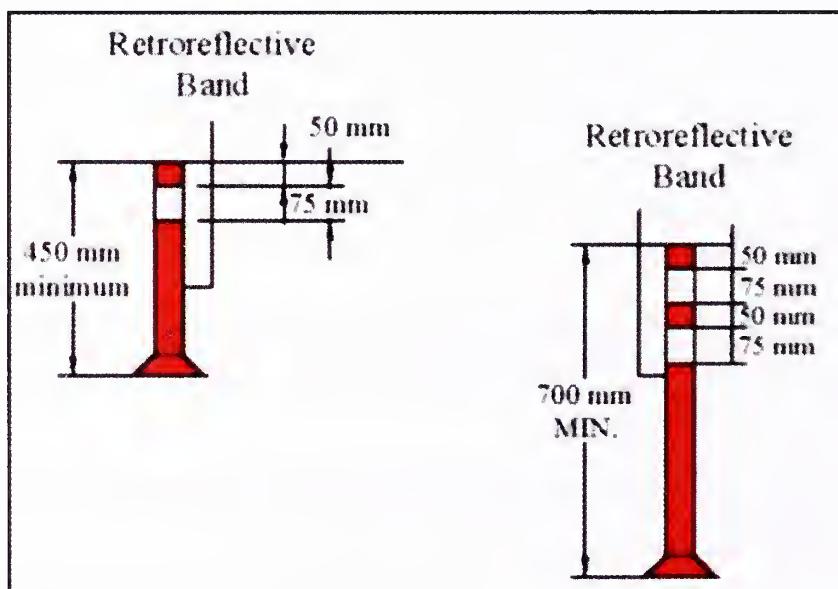
Speed	Size	Cones in Transition Area	Cones in Straight Portion
Upto 65 kmph	500 mm	1.5 m	9 m
66 - 100 kmph	750 mm	1.5 m	9 m
> 100 kmph	1000 mm	1.5 m	9 m

A minimum 300 mm clear distance shall be provided from the traffic edge lane marking to the traffic cones

Application : The traffic cones are ideally proposed for temporary works and maintenance activities. Since the traffic cones are easily portable and can be installed and removed quickly, it can be used at places where they are required to be installed and dismantled quite often. Traffic cones can also be tied up with reflective tape to provide longitudinal guiding line. The traffic cones along with tape shall form a regular and smooth geometry of traffic path, so as to streamline the traffic in a well-defined path.

5.2.2 *Tubular markers*

Tubular markers as shown in **Fig. 5.11** may be used effectively to divide opposing lanes of road users, or to divide vehicular traffic lanes when two or more lanes of moving vehicular traffic are kept open in the same direction, and to delineate the edge of a pavement drop-off where space limitations do not allow the use of larger devices. These tubular structures shall be flexible plastic bollards.

**Fig. 5.11 Tubular Markers**

When a non-cylindrical tubular marker is used, it shall be attached to the pavement in a manner such that the width facing road users meets the minimum requirements. A tubular marker shall be attached to the pavement to display the minimum 50 mm width of reflective bands to the approaching road users. The application of tubular markers is presented in **Table 5.10**.

Table 5.10 Application (Spacing) of Tubular Markers Along the Running Direction***

Speed (kmph)	Size of the Tubular Marker/Bollard (in mm)	Between Two Opposite Streams of Traffic	Between Two Streams on Same Direction	At the End for Pavement Edge Drop
Upto 65	450 mm	9 m	6 m	9 m
66 - 100	700 mm	9 m	6 m	9 m
> 100	N.A.			Not Applicable

*** Tubular Markers will be used in situation where there is acute space constraints to install larger devices in roads of low traffic volume.
A minimum 300 mm clear distance shall be provided from the traffic lane marking to the tubular markers.

Application : Tubular markers are suitable in urban or in rural sections where pedestrian and cyclist movements are there due to abutting roadside activities. If the traffic approaching in one direction is required to be diverted into two different pathways, it can be used in longitudinal direction along with traffic lane line marking. It is generally used where traffic moves at relatively slow speed and traffic volume is relatively high.

5.2.3 *Hazard markers*

The hazard markers shall be alternating yellow and black retro-reflective stripes, sloping downward at an angle of 45 degrees in the direction of vehicular traffic. With respect to the position of traffic movement and road side hazard, it can be for either left or right i.e. OHM (Left & Right). If traffic can pass on both sides, it shall be Two Way Hazard Markers (TWHM). The one-way and two-way hazard markers are shown in **Fig. 5.12** and the placement of hazard markers is presented in **Fig. 5.13**.

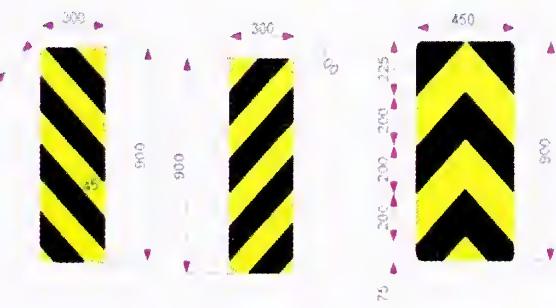


Fig. 5.12 Hazard Markers OHM (Left & Right) & TWHM



Fig. 5.13 Application of OHM (Left & Right) & TWHM

Application : All exposed roadside fixed objects, like tree, culvert/bridge parapet, etc. adjacent to traffic movement are to be delineated with hazard markers just in front of them and also at location of diversion or gore area where traffic is expected to change the direction due to temporary or permanent diversion.

5.2.4 Drums

Drums are generally of lightweight and with deformable materials. They shall be a minimum of 800 mm minimum, in height and have at least a 300 mm minimum width regardless of orientation **Fig. 5.14**. The markings on drums shall be horizontal, circumferential, alternating red and white retro-reflective stripes 100 to 150 mm wide. Each drum shall have a minimum of two red and two white stripes with the top stripe being red. Any non-retro-reflectORIZED spaces between the horizontal red and white stripes shall not exceed 75 mm wide. Drums shall have closed tops that will not allow collection of construction debris or other debris.

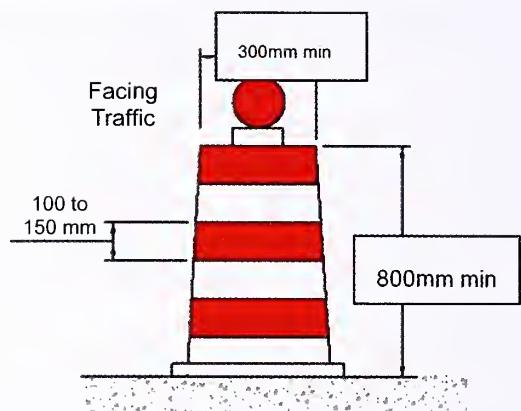


Fig. 5.14 Drum

Drums are highly visible and give the appearance of being formidable obstacles, and therefore, command the respect of road users. They are portable enough to be shifted from place to place within a work zone in order to accommodate changing conditions, but are generally used in situations where they will remain in place for a prolonged period of time.

Although drums are most commonly used to channelize or delineate traffic flow, they may also be used alone or in groups to mark specific locations, including as crash attenuators.

Drums should not be used for pedestrian channelization or as pedestrian barriers in work zones or along sidewalks unless they are continuous between individual devices. Drums should not be weighted with sand, ballast, water, or any material to the extent that would make them hazardous to road users or workers when struck. Ballast shall not be placed on the top of a drum. Drums used in regions susceptible to freezing should have drain holes in the bottom so that water will not accumulate and freeze causing a hazard, if struck by traffic.

The application of drum delineators is permitted in work sites where there is adequate space to install drums with adequate minimum clearance distance. In Indian context, in areas of high vandalism the drum channelization can be explored and spacing indicated in **Table 5.9** will be applicable for drum channelization also.

Application : Drums are ideal for work sites of long construction period and also where length of work site is relatively long and they are placed parallel to traffic movement path. Since drums occupy more space than other channelizing devices, it can be used at locations where it can be placed with adequate lateral clearance set forth in this guideline. Drums shall be tied up with proper reflective tape. The drums along with tape shall form a regular and smooth geometry so as to streamline the traffic in a well-defined path.

5.2.5 Barricades

Barricades are intended to provide containment without significant deflection or deformation under impact and to redirect errant vehicles along the barrier. They are designed to be easily

relocated and have four specific functions such as to:

- i) Prevent traffic from entering work areas including excavations or material storage sites;
- ii) Provide protection and perceived safety to both traffic as well as construction workers;
- iii) Separate two-way traffic; and
- iv) Protect construction, such as form work for culverts and other exposed objects, so as to avoid hazard to road users.

Barricades can be portable or permanent. Portable barricades should be stable under adverse weather conditions and appear substantial but not so much as to cause excessive damage to the vehicle, if they are struck. **Fig. 5.15** shows standard barricades; Type I and II are portable, whereas Type III and Type IV (**Fig. 5.16**) are permanent. The recommended dimensions of various components are given in **Table 5.11** and the details of Type IV barricades are shown in **Fig. 5.16**.

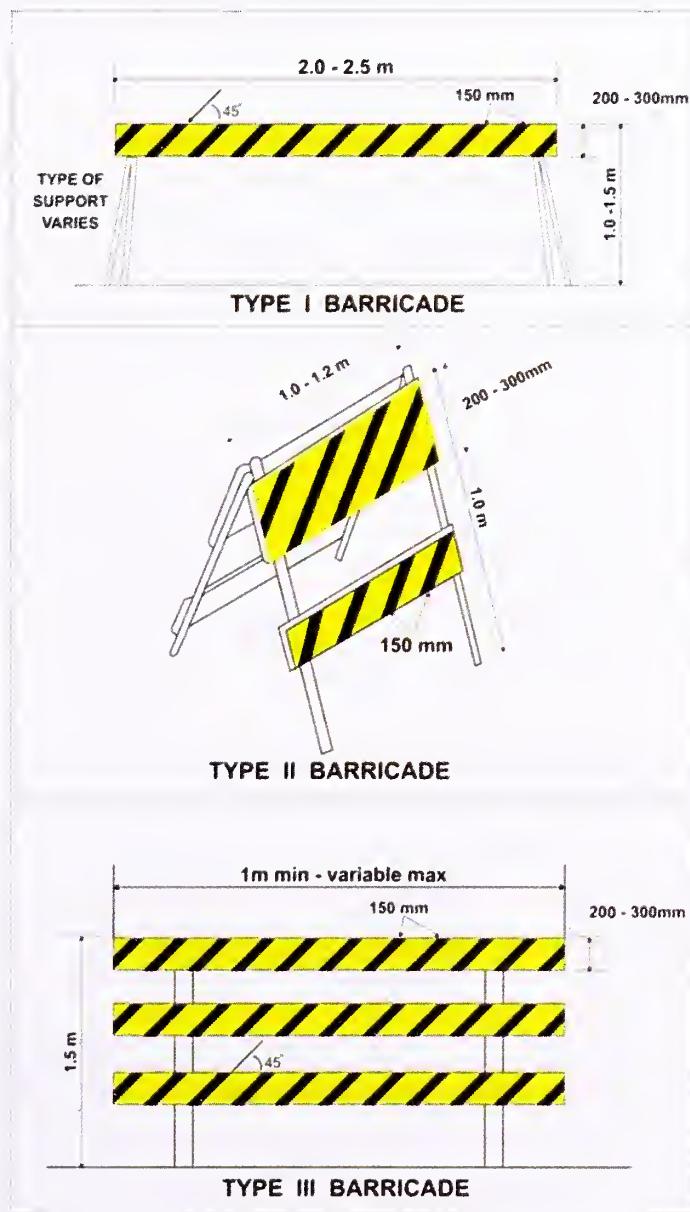
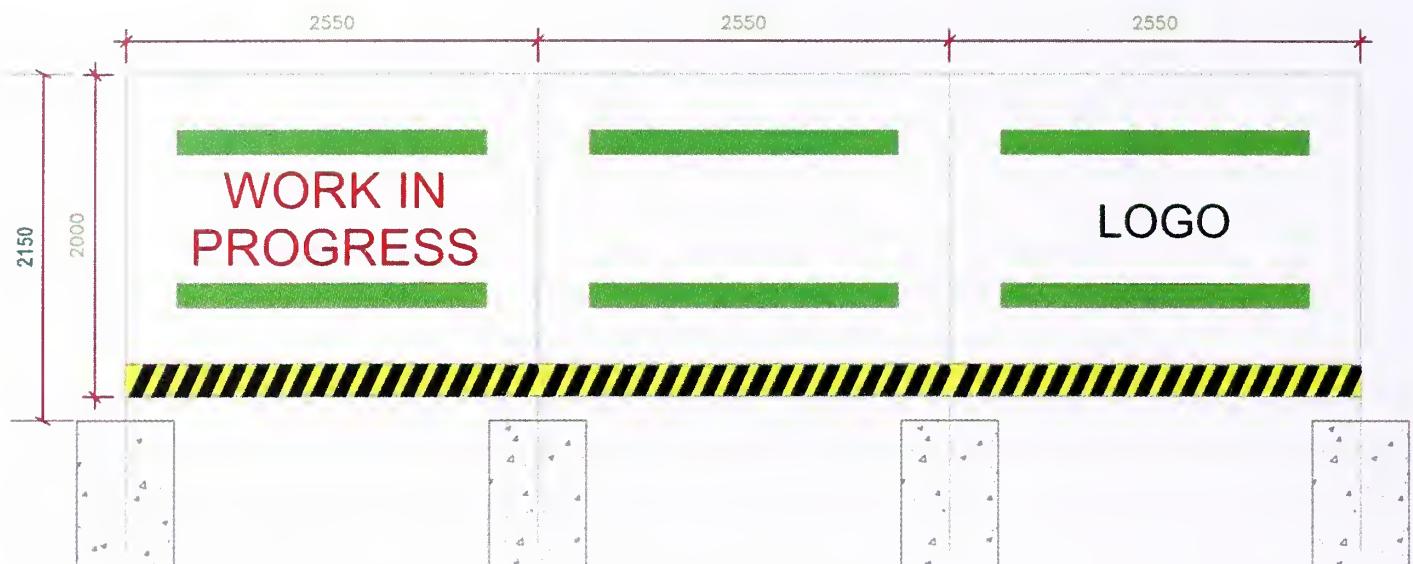
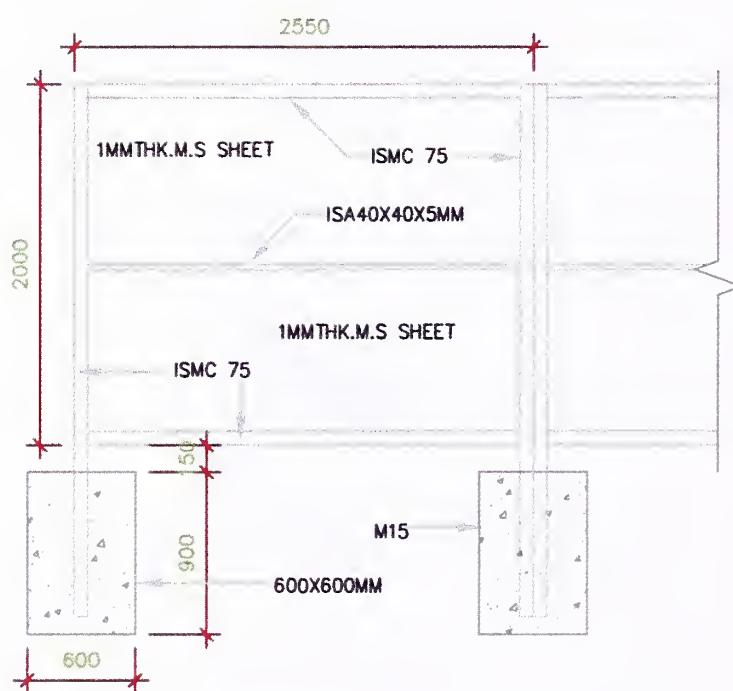


Fig. 5.15 Standard Barricades



ELEVATION OF ONE UNIT OF TEMPORARY BARRICADING

All dimensions are in millimeters.



ISMC 75	= 76.50 Kg
ISA 40X40X6	=12.6Kg
CONCRETE	= 0.648
CUBIC M.M.S SHEET	=39.25 Kg
SHUTTERING	=2.16 SQM

DETAILS OF FIX BARRICADING BOARDS

All dimensions are in millimeters.

Fig. 5.16 Type IV Barricade

Table 5.11 Characteristics and Dimensions of Barricades

Type/Component	I	II	III	IV
Width of Rail	200 mm - 300 mm	200 mm - 300 mm	200 mm - 300 mm	2000 mm (Width of barricade)
Length of Rail	2.0 m - 2.5 m	1.0 m - 1.2 m	1 m min - variable max.	2550 mm (Length of barricade)
Width of Strip	150 mm	150 mm	150 mm	150 mm
Height of Barricade	1.0 - 1.5 m	1.0 m	1.5 m	2.15 m
Type of Frame	Heavy 'A' Frame	Light 'A' Frame	Fixed, Demountable	Fixed, Demountable
Flexibility	Essentially movable	Portable	Essentially Permanent	Essentially Permanent
Retro-reflective sheeting	Class B sheeting as per IRC:67-2012.			

The horizontal members of Type I and II barricades may be of wooden planks and metal. These should be 200 mm-300 mm wide and should be painted in alternate yellow and black stripes of 150 mm width. The stripes should slope away at an angle of 45° in the direction traffic is to pass. Where the barricades extend entirely across the carriageway, the stripes should slope downward towards the direction the traffic must turn in detour. Where both left and right turns are provided for, the chevron stripes should slope downward in both directions from the centre of the barricade. The entire area of chevrons should be reflectorised so as to be visible from safe distance.

Application : Type I or Type II barricades shall be used when traffic is redirected. These barricades can be used inter-changeably and are more useful in repair work that is generally initiated on emergency basis. The support should be of an "A" frame configuration or hinged or otherwise flattened at the top to permit convenient folding and stacking for transportation. Since these barricades are susceptible to overturning in wind, their stability can be improved through ballast.

Type III barricades are the permanent type and can be made of wood or metal. These are erected at the point of closure when a road section is closed to traffic in construction projects. They may extend completely across a roadway and its shoulders or from kerb to kerb. Where provision must be made for the access of construction and supervision vehicles, type III barricades must be provided with a gate or moveable section that can be opened and/or closed as required. Signs such as "ROAD CLOSED" and "DETOUR ARROWS" should be erected on the fixed barricade.

Type IV barricade are to be used in road construction works of long duration, in urban areas. They serve the purpose of screening and separation of traffic from work area but should not be expected to provide much protection. Therefore, they should be installed at such locations which should prevent all kinds of entry and exit by the road users/construction workers to

work space and also those works which are not intended to be seen by public, lest it can distract the driving attention. These should not be used on roads/highways having high traffic volume and speed since they do not provide much protection when impacted.

5.2.6 *Direction indicator barricades*

The direction indicator barricade **Fig. 5.17** shall consist of a one-direction large arrow sign mounted above a diagonal striped, horizontally aligned, retro-reflective rail.

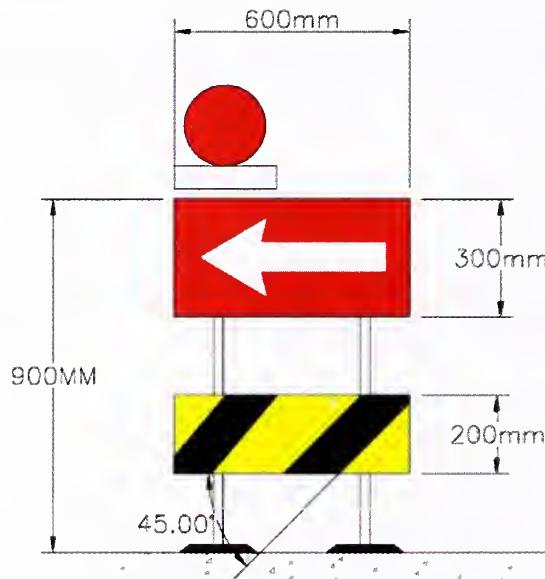


Fig. 5.17 Direction Indicator Barricade

The one-direction large arrow sign shall be black on a yellow background. The stripes on the bottom rail shall be alternating yellow and black retro-reflective stripes sloping downward at an angle of 45° in the direction road users are to pass. The stripes shall be 100 mm wide. The one-direction large arrow sign shall be of size 600 x 300 mm. The bottom rail shall have a length of 600 mm and a height of 200 mm.

The direction indicator barricade, including any associated ballast or lights, should be crash worthy.

Application : The direction indicator barricade may be used in tapers, transitions, and other areas where specific directional guidance to drivers is necessary. If used, direction indicator barricades should be used in series to direct the driver through the transition and into the intended travel lane.

5.2.7 *New jersey barrier*

The New Jersey Barriers are 1.5 m to 2.0 m long pre-cast reinforced concrete modular pieces with shaped ends that can be interlocked and connected. Where the road works are to be undertaken which would continue for some time or where the space is limited and there is a need for the protection of the work force, particularly where the speed of passing traffic may be high, New Jersey Barrier as shown in **Fig. 5.18** may be used.



Fig. 5.18 New Jersey Barrier

Application : New Jersey barrier is to be used to barricade or segregate work space from traffic, where traffic moves parallel to barricading. It is intended to minimize damage in case of any accident. New Jersey barrier shall be provided at location especially where there is edge drop of more than 300 mm between the carriageway and adjacent strip of land as part of work area. While installing barricade, the minimum clearance as shown in Fig. 5.19 shall be kept at all time.

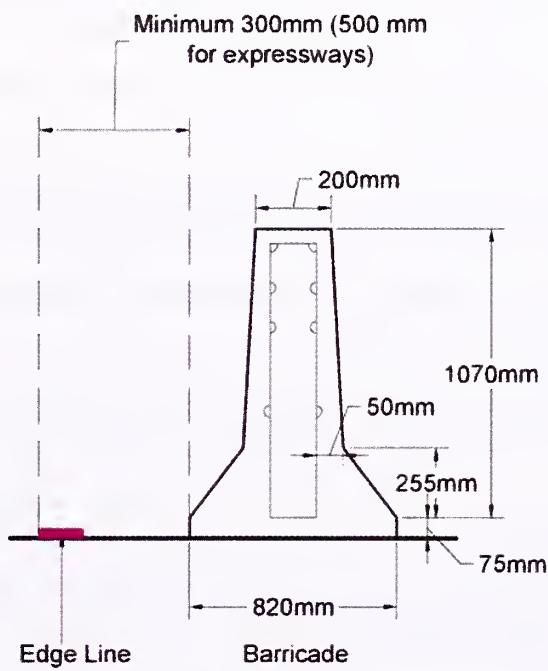


Fig. 5.19 Placement of Barricade

5.2.8 Water-filled barricades

Water-filled barricades are modular water filled plastic containers of various sizes and shapes, and an example is given in Fig. 5.20. Hollow polyethylene barriers in trapezoidal shape of about 80 cm to 100 cm length have been developed for short-term applications where

portability is important. These plastic barriers are normally filled with water after placement on-site to provide a moderate level of stability and crash protection. These barriers can also be filled with soil/sand, or concrete to produce a heavier barrier with greater crash protection, at the cost of reduced portability. Their use should be carefully controlled until more experience is gained with them. They will enable narrower traffic lanes and buffer zones to be employed, where space is a premium and vehicle speed is likely to be high.



Fig. 5.20 Water Filled Barricade

- They shall be minimum 0.7 m tall for major roads and expressway, and 0.5 m tall for other roads.
- Each unit shall come with interlocking devices for use on tangent/straight and horizontal curves with mounting arrangement to fix devices for lighting.
- It is very stable and offers better resistance to vehicle impact as compared to traffic cones and barricades.
- It shall be used as traffic delineator for long-term works, to separate traffic from pedestrians when footpath is temporarily diverted next to a carriageway.
- It shall be placed at least 0.5 m from the edge of the carriageway for expressway and 0.3 m for other roads as shown in **Fig. 5.19**.
- Reflective sheeting to be placed on these plastic barricades shall conform to Class B as per IRC:67-2012.

Application : Water filled barricade is recommended for segregating and barricading the workspace and vehicular movement, where traffic is expected to change direction of movement on account of temporary diversion plan. Forgiving type water filled barricade are required in transition area, where vehicles are likely to hit them if they fail to negotiate the deflected pathway provided as part of temporary diversion plan. The water filled barricade shall be conspicuous enough to be seen by drivers under the headlight beam.

5.2.9 Detectable edging for pedestrians

Various detectable edging and their application for pedestrians include:

- Prefabricated lightweight sections of plastic, metal, or other suitable materials that are interconnected and fixed in place to form a continuous edge.
- These are placed at ground level to provide a continuous connection between channelizing devices located at intervals along the edge of the sidewalk or walkway.
- Sections of lumber interconnected and fixed in place to form a continuous edge.
- In-situ asphalt or concrete kerb.
- Prefabricated concrete kerb sections that are interconnected and fixed in place to form a continuous edge.
- Continuous temporary traffic barrier or longitudinal channelizing barricades placed along the edge of the sidewalk or walkway that provides a pedestrian edging at ground level.
- Chain link or other fencing equipped with a continuous bottom rail.

Detectable pedestrian edging should be red or yellow and should match the color of the adjacent channelizing devices or traffic control devices, if any are present. **Figs. 6.2 and 6.3** may be referred.

5.2.10 Delineators

Delineators are generally combined with or are used to supplement other traffic control devices. They shall be mounted on crash worthy supports so that the reflecting unit is approximately 1.2 m above the nearside carriageway edge. The standard color for delineators used along both sides of two-way streets and highways and the right side of one-way roadways shall be white. Delineators used along the left side of one-way roadways shall be yellow. The tubular markers shown in **Fig. 5.11** and other similar devices as given in IRC:79 including the cones (**Fig. 5.10**), drums (**Fig. 5.14**) can be used as delineators.

Spacing along roadway curves should be such that several delineators are always visible to the driver. Delineators may be used in work zones to indicate the alignment of the roadway and to outline the required vehicle path through the work zone.

Application : Delineators are appropriate at location where there is no edge drop at all and should serve as alignment marker so that driver can judge the carriageway edges while passing through the work zone. The retro-reflective delineators can be suitably placed at regular interval, e.g. 2 m spacing if used in transition portion and 9 m spacing if used in straight reaches. Delineators when tied up with proper reflective tape shall form a regular and smooth geometry to guide the traffic in the changed path at the intended speed.

5.3 Temporary Pavement Markings & Road Studs

Pavement markings shall be maintained along paved streets and highways in all long- and intermediate-term stationary work zones. All pavement markings shall be in accordance with IRC:35. Pavement markings shall match the markings in place at both ends of the work zone. Pavement markings shall be placed along the entire length of any surfaced detour or temporary roadway prior to the detour or roadway being opened to road users.

Warning signs, channelizing devices and delineation shall be used to indicate required road user paths in work zones where it is not possible to provide a clear path by pavement markings. All pavement markings and devices used to delineate road user paths shall be carefully reviewed during daytime and also during night time.

For long-term stationary operations, pavement markings in the temporary traveled way that are no longer applicable shall be removed or obliterated as soon as practical. Pavement marking obliteration shall leave a minimum of pavement scars and shall remove old marking material. Painting over existing pavement markings with black paint or spraying with asphalt shall not be accepted as a substitute for removal or obliteration.

Road users should be provided pavement markings within a work zone comparable to the pavement markings normally maintained along such roadways, particularly at either end of the work zone.

The intended vehicle path should be defined by markings in day, night, and twilight periods under both wet and dry pavement conditions.

The colour of pavement markings shall be white or yellow conforming to IRC:35. The material used should be hot/cold thermoplastic or ordinary paint. If ordinary marking paint is used, the conspicuity shall be ensured throughout the construction phase and if required reapplication for a few times, as ordinary road marking paint get defaced within a short time. The word messages like 'DO NOT PASS', 'PASS WITH CARE' and 'NO PASSING ZONE' can be written upon the pavement surface, and for this principles and dimensions laid out in IRC:35 may be followed. The WTMP shall include location and type of payment markings to meet the site requirements and conforming to IRC 35. A typical pavement marking details is shown in Fig. 5.21.

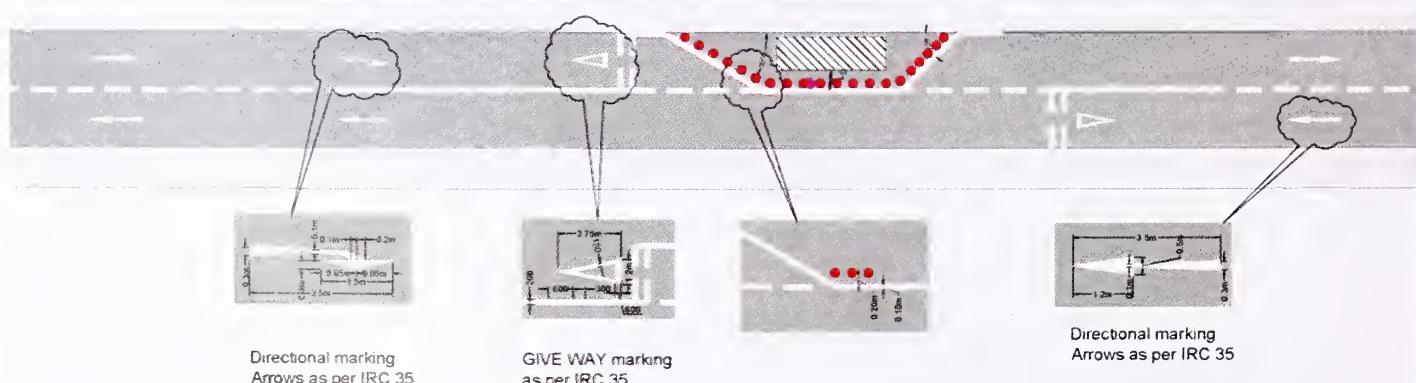


Fig. 5.21 Pavement Markings

5.3.1 *Road studs*

The pavement markings shall be reinforced with road studs and the color of the road studs shall be amber. Where it is essentially required to divide the two streams of traffic, and bi-directional road studs shall be provided at 1.5 m to 9 m spacing. Roads studs shall be used at acute temporary diversions to reinforce the temporary continuous marking and also where contra-flow situation is required to be adopted as part of work zone traffic management plan shown in **Fig. 5.22**.

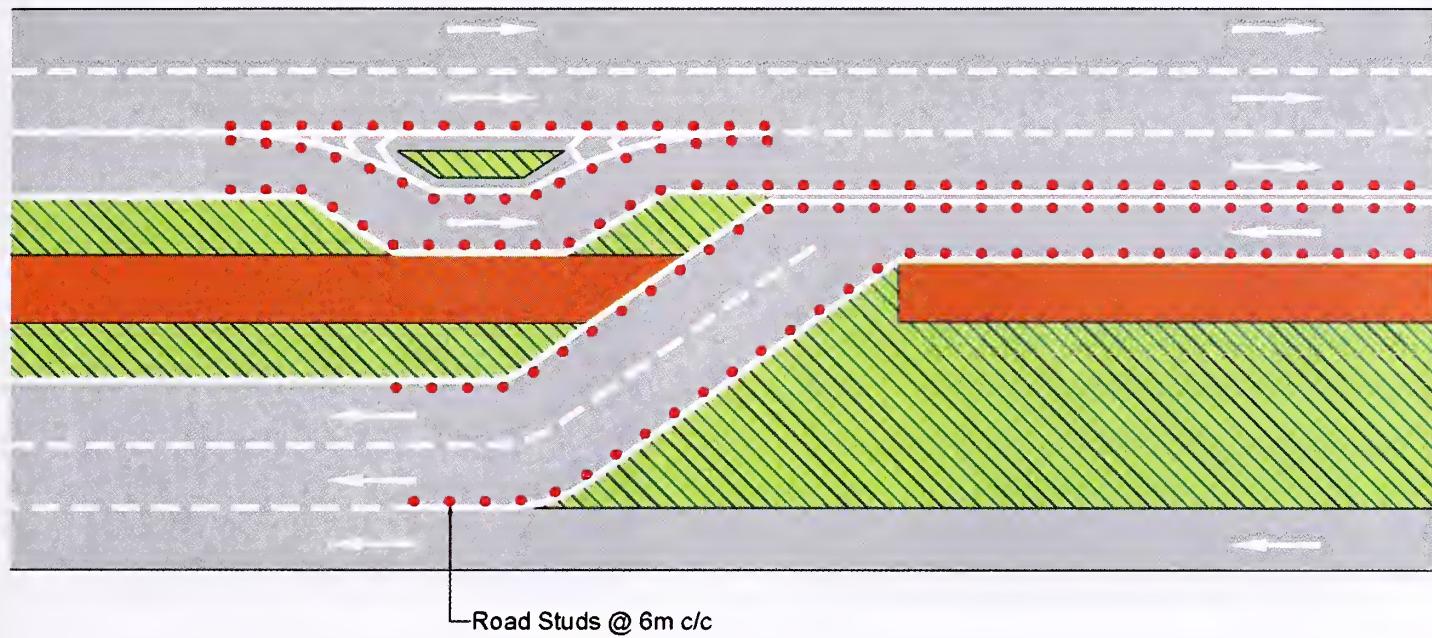


Fig. 5.22 Placement of Road Studs

5.4 **Lighting Devices & Variable Message Signs**

5.4.1 *Lighting devices*

Lighting devices should be provided in work zones based on engineering judgment. When used to supplement channelization, the maximum spacing for warning lights should be identical to the channelizing device spacing requirements.

Four types of lighting devices are commonly used in work zones. They are floodlights, flashing warning beacons, warning lights, and steady-burn electric lamps.

Lighting devices may be used to supplement retro-reflectorized signs, barriers, and channelizing devices. During normal daytime maintenance operations, the functions of flashing warning beacons may be provided by high-intensity rotating, flashing, oscillating, or strobe lights on a maintenance vehicle. Some illustrations are given in **Fig. 5.23**.

5.4.2 *Floodlights*

Utility, maintenance, or construction activities on highways are frequently conducted during nighttime periods when vehicular traffic volumes are lower. Large construction projects are sometimes operated on a double-shift basis requiring night work.



Fig. 5.23 Types of Lighting Devices

When nighttime work is being performed, floodlights should be used to illuminate the work area, equipment crossings, and other areas.

The adequacy of the floodlight placement and elimination of potential glare should be determined by driving through and observing the floodlighted area from each direction on all approaching roadways after the initial floodlight setup, at night, and periodically.

Desired illumination levels vary depending upon the nature of the task involved. An average horizontal luminance of 50 lux can be adequate for general activities. Tasks requiring high levels of precision and extreme care may require an average horizontal luminance of 216 lux.

5.4.3 *Flashing warning beacons*

Flashing warning beacons are often used to supplement a traffic control device. Flashing warning beacon shall be a flashing yellow light with a minimum nominal diameter of 200 mm with rotating amber lights equipped to be operated over the entire 24 hour duration. The temporary terminus of an expressway is an example of a location where flashing warning beacons alert drivers to the changing roadway conditions and the need to reduce speed in transitioning from the expressway to another roadway type.

5.4.4 *Warning lights*

Type A, Type B, Type C, and Type D 360° warning lights are portable, powered, yellow, lens-directed, enclosed lights. When warning lights are used, they shall be mounted on signs or channelizing devices in a manner that, if hit by an errant vehicle, they will not penetrate through the windshield. The maximum spacing for warning lights should be identical to the channelizing device spacing requirements.

Flashing warning lights shall not be used for delineation, as a series of flashers fails to identify the desired vehicle path.

Type A low-intensity flashing warning lights, Type C steady-burn warning lights, and Type D 360° steady-burn warning lights shall be maintained so as to be capable of being visible on a clear night from a distance of 900 m. Type B high-intensity flashing warning lights shall be maintained so as to be capable of being visible on a sunny day when viewed without the sun directly on or behind the device from a distance of 300 m. Warning lights shall have a minimum mounting height of 750 mm to the bottom of the lens.

Type A low-intensity flashing warning lights are used to warn road users during night time that they are approaching or proceeding in a potentially (isolated) hazardous area. Type A warning lights may be mounted on channelizing devices.

Type B high-intensity flashing warning lights are used to warn road users during both daylight and nighttime hours that they are approaching a potentially hazardous area.

Type C steady-burn warning lights and Type D 360° steady-burn warning lights may be used during night time to delineate the edge of the traveled way and channelize traffic.

When used to delineate a curve, Type C and Type D 360° warning lights should only be used on devices provided on the outside of the curve, and not on the inside of the curve as these may be hit by the passing traffic.

5.4.5 *Temporary traffic control signals*

Temporary traffic control signals used to control road user movements through work zones and in other work zone situations shall meet the applicable provisions.

Temporary traffic control signals are typically used in work zones such as temporary haul road crossings; temporary one-way operations along a one-lane, two-way highway; temporary one-way operations on bridges, reversible lanes, and intersections.

One-lane, two-way vehicular traffic flow requires an all-red interval of sufficient duration for road users to clear the portion of the work zone controlled by the traffic control signals. Safeguards shall be incorporated to avoid the possibility of conflicting signal indications at each end of the work zone.

Temporary traffic control signals may be portable or mounted on temporarily fixed supports. Temporary traffic control signals should only be used in situations where temporary traffic

control signals are preferable to other means of traffic control, such as changing the work staging or work zone size to eliminate one-way vehicular traffic movements, using flaggers to control one-way or crossing movements, using STOP or YIELD signs, and using warning devices alone.

5.4.6 Portable variable message signs

Portable message signs shall be the devices with the flexibility to display a variety of messages. Each message shall consist of either one or two phrases. A phrase shall consist of up to three words of eight characters per word. The message to be conveyed should not exceed three phrases displayed in three lines. Portable variable message signs have a wide variety of applications in work zones including: roadway, lane, or ramp closures, crash or emergency incident management, width restriction information, speed control or reductions, advisories on work scheduling, road user management and diversion, warning of adverse conditions, and other operational control.

The primary purpose of portable variable message signs in work zones is to advise the road user of unexpected situations. Some typical applications include the following:

- a) Where the speed of vehicular traffic is expected to drop substantially;
- b) Where significant queuing and delays are expected;
- c) Where adverse environmental conditions are present;
- d) Where there are changes in alignment or surface conditions;
- e) Where advance notice of ramp, lane, or roadway closures is needed;
- f) Where changes in the road user pattern occur.

The components of a portable variable message sign should include: a message sign panel, control systems, a power source, and mounting and transporting equipment.

The front face of the sign should be covered with a protective material. The color of the elements should be yellow on a black background.

Portable variable message signs should be visible from 800 m under both day and night conditions. For a trailer or large truck mounted sign, the letter height should be a minimum of 450 mm. For variable message signs mounted on service patrol trucks, the letter height should be a minimum of 250 mm.

The message panel should have adjustable display rates (minimum of 3 seconds per phrase), so that the entire message can be read at least twice at the posted speed, the off-peak 85th-percentile speed prior to work starting, or the anticipated operating speed.

Messages should be designed taking into account the following factors:

- a) Each phrase should convey a single thought.
- b) If the message can be displayed in one phrase, the top line should present the problem, the center line should present the location or distance ahead, and the bottom line should present the recommended driver action.

- c) The message should be as brief as possible.
- d) When a message is longer than two phrases, additional Portable Variable Message signs should be used.
- e) When abbreviations are used, they should be very conventional and easily understood.

The message sign panel may vary in size. Smaller letter sizes may be used on a Portable Variable Message sign mounted on a trailer or large truck provided that the message is legible from at least 200 m, or mounted on a service patrol truck provided that the message is legible from at least 100 m.

Two portable variable message signs may be used for the purpose of allowing the entire message to be read twice at the posted speed.

The control system shall include a display screen upon which messages can be reviewed before being displayed on the message sign. The control system shall be capable of maintaining memory when power is unavailable.

Portable variable message signs shall be equipped with a power source and a battery back-up to provide continuous operation when failure of the primary power source occurs.

The mounting of portable variable message signs on a trailer, a large truck, or a service patrol truck shall be such that the bottom of the message sign panel shall be a minimum of 2.1 m above the roadway in urban areas and 1.5 m above the roadway in rural areas when it is in the operating mode.

The text of the messages shall not scroll or travel horizontally or vertically across the face of the sign. Portable variable message signs should be used as a supplement to and not as a substitute for conventional signs and pavement markings. When portable variable message signs are used for route diversion, they should be placed far enough in advance of the diversion to allow road users ample opportunity to perform necessary lane changes, to adjust their speed, or to exit the affected highway.

The portable variable message signs should be sited and aligned to provide maximum legibility. Multiple portable variable message signs should be placed on the same side of the roadway. Portable Variable Message signs should be placed on the shoulder of the roadway or, if practical, further from the traveled lane. They should be delineated with retro-reflective traffic control devices. When Portable Variable Message signs are not being used, they should be removed; if not removed, they should be shielded; or if the previous two options are not feasible, they should be delineated with retro-reflective traffic control devices.

5.4.7 Arrow boards

An arrow panel shall be a sign with a matrix of elements capable of either flashing or sequential displays. This sign shall provide additional warning and directional information to assist in merging and controlling road users through or around a work zone.

An arrow panel in the arrow or chevron mode should be used to advise approaching traffic of a lane closure along major multi-lane roadways in situations involving heavy traffic volumes, high speeds, and/or limited sight distances, or at other locations and under other conditions where road users are less likely to expect such lane closures.

If used, an arrow panel should be used in combination with appropriate signs, channelizing devices, or other traffic control devices.

An arrow panel should be placed on the shoulder of the roadway or, if practical, further from the traveled lane. It should be delineated with retro-reflective traffic control devices. When an arrow panel is not being used, it should be removed; if not removed, it should be shielded; or if the previous two options are not feasible, it should be delineated with retro-reflective temporary traffic control devices.

Arrow panels shall meet the minimum size, legibility distance, number of elements, and other specifications shown in **Table 5.12** and **Fig. 5.24**. Type 'A' arrow panels are appropriate for use on low-speed urban streets. Type 'B' arrow panels are appropriate for intermediate-speed facilities and for maintenance or mobile operations on high-speed roadways. Type 'C' arrow panels are intended to be used on high-speed, high-volume motor vehicle traffic control projects. Type 'D' arrow panels are intended for use on authorized vehicles.

Table 5.12 Advance Warning Arrow Display Specifications

Panel Type	Minimum Size Length x Width	Minimum Legibility Distance	Minimum Number of Elements
A	1200 x 600 mm	0.8 km	12
B	1500 x 750 mm	1.2 km	13
C	2400 x 1200 mm	1.6 km	15
D	None*	0.8 km	12

Type A, B, and C arrow panels shall have solid rectangular appearances. A Type D arrow panel shall conform to the shape of the arrow. All arrow panels shall be finished in non-reflective black. The arrow panel shall be mounted on a vehicle, a trailer, or other suitable support. The minimum mounting height of an arrow panel should be 2.1 m from the roadway to the bottom of the panel, except on vehicle-mounted panels, which should be as high as practical. A vehicle-mounted arrow panel should be provided with remote controls. Arrow panel elements shall be capable of at least a 50 percent dimming from full brilliance. The dimmed mode shall be used for nighttime operation of arrow panels. Full brilliance should be used for daytime operation of arrow panels. The arrow panel shall have suitable elements capable of the various operating modes. The color presented by the elements shall be yellow.

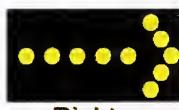
Operating Mode	Panel Display (Type C panel illustrated)	
I. At least one of the three following modes shall be provided:	(Right arrow shown; left is similar)	
Flashing Arrow		Move/Merge Right
Sequential Arrow		
Sequential Chevron		
II. The following mode shall be provided: Flashing Double Arrow		
III. The following mode shall be provided: Flashing Caution		or 

Fig. 5.24 Typical Illustration of Arrow Message

Guidance :

If an arrow panel consisting of a bulb matrix is used, the elements should be recess-mounted or equipped with an upper hood of not less than 180 degrees.

The minimum element on-time shall be 50 percent for the flashing mode, with equal intervals of 25 percent for each sequential phase. The flashing rate shall be not less than 25 and not more than 40 flashes per minute.

An arrow panel shall have the following three mode selections:

- a) A Flashing Arrow, Sequential Arrow, or Sequential Chevron mode;
- b) A flashing Double Arrow mode; and
- c) A flashing Caution mode.

An arrow panel in the arrow or chevron mode shall be used only for stationary or moving lane closures on multi-lane roadways.

For shoulder work, blocking the shoulder, for roadside work near the shoulder, or for temporarily closing one lane on a two-lane, two-way roadway, an arrow panel shall be used only in

the caution mode. For a stationary lane closure, the arrow panel should be located on the shoulder at the beginning of the merging taper. Where the shoulder is narrow, the arrow panel should be located in the closed lane. When arrow panels are used to close multiple lanes, a separate arrow panel shall be used for each closed lane.

When arrow panels are used to close multiple lanes, if the first arrow panel is placed on the shoulder, the second arrow panel should be placed in the first closed lane at the beginning of the second merging taper. When the first arrow panel is placed in the first closed lane, the second arrow panel should be placed in the second closed lane at the downstream end of the second merging taper.

For mobile operations where a lane is closed, the arrow panel should be located to provide adequate separation from the work operation to allow for appropriate reaction by approaching drivers. A vehicle displaying an arrow panel shall be equipped with high-intensity rotating, flashing, oscillating, or strobe lights. Arrow panel(s) shall not be used to laterally shift traffic. A portable Variable Message Sign (VMS) may be used to simulate an arrow panel display.

SECTION 6

MEASURES FOR VULNERABLE ROAD USERS (VRUs)

6.1 Measures for VRUs

Where pedestrians, including differently abled persons and people with visual impairment, have to negotiate a work site or to cross the road within a work site, they shall be provided with and directed to suitably constructed and protected temporary footpaths and crossing points, or formal pedestrian crossings, and also refuges, where such provisions are made. Such facilities shall meet the requirements described in these guidelines. Pedestrian and cycle tracks shall be of same width and facilities that were existing prior to the works.

6.2 Guidance

In proposing measures for devices for pedestrians, people of disabilities and for cyclists/other non motorized vehicles, in an area of road works, the following guidance shall prevail:

- It should be ensured that there is no danger to pedestrians from falling objects or sharp edges, and these road users will not fall over or bump into anything causing personal injury.
- Scaffolding be marked with white bands at eye level and allow at least 2.1 m head room. It should be ensured that the barriers can be detected easily by a visually impaired person using a cane stick.
- Kerb ramps or raised footpath should be provided to help blind, poorly sighted, elderly and disabled people and for those with prams or wheelchairs.
- Pedestrian safety shall be ensured by provision of devices such as raised rumble strip markings and speed humps near pedestrian crossings, where traffic speed is likely to be high. If excavations are deeper than 0.3 m, stronger barricades will be required like water filled barricades to protect pedestrians and cyclists.
- The safety buffer is provided in the carriageway, if the works are closer to the kerb than the width of the lateral safety buffer clearance.
- If the works are on or near formally marked pedestrian crossings, care must be taken to avoid confusion to pedestrians.
- Clear guidance must be given as to where they are expected to cross while the works are ongoing.

6.3 Barriers for Pedestrians & Cyclist

Pedestrian barrier should be used to mark out any temporary footpath. Water filled barricades must always be used to protect pedestrians from traffic, excavations, plant or materials as shown in examples in **Fig. 6.1**.

Overhead Protection

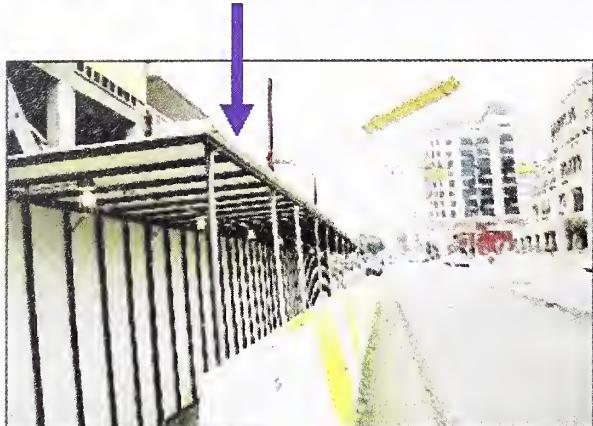


Fig. 6.1 Protective Pedestrian Walking Space

Place warning lights at the end of the barriers at night. Portable pedestrian barriers, which may include mesh, if used, should be reasonably rigid and have:

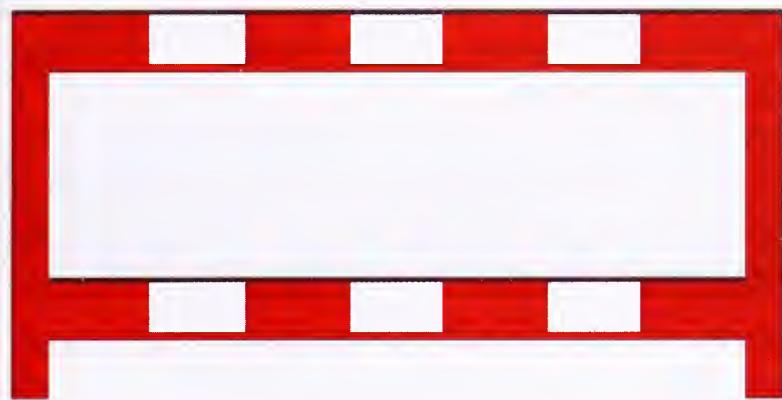
- a hand rail fixed at between 1.0 m and 1.2 m above ground level, which should be reasonably smooth and rigid for pedestrians to hold to obtain guidance and some measure of support;
- a visibility panel at least 150 mm deep which may be integral with the hand rail or if separate must be fixed, so that its upper edge is a minimum of 0.9 m above ground level. Visibility panels of yellow, white or orange color are best for detection by partially sighted people, while the red and white rail gives a good contrast and provides interchangeability with traffic barriers; and
- a tapping rail (for blind people with a white stick) of min depth 150 mm with a lower edge at ground level or up to a maximum height of 200 mm above the ground.

When covers are required to be removed from underground chambers or manholes, a flag man shall always be there, and also a barrier with a handrail fixed no lower than 0.8 m above ground level will be satisfactory. In this case, the barrier must be large enough to enclose the opening. Pedestrian barrier can be used to block and to redirect the pedestrian movement, and plastic mesh barrier can segregate the pedestrians and construction activity area as given in **Fig. 6.2**. The illustration of how to put them into practices is shown in **Fig. 6.3**.

Plastic pedestrian barrier shall be stable and not easily blown over, or displaced by moving traffic or pedestrians. It is sometimes a proprietary-made product of plastic post/frame with mounting devices with reflective discs or lamps. The material of the barricade and the ballast added to the base to provide stability shall not become a potential hazard if struck. The portability of these devices is of particular advantage in emergencies or work that involve their regular displacement. It shall be erected without gaps along pedestrian paths throughout the work zone for the control of pedestrian movement to prevent injury or interference with the construction work activity. They may be erected at spacing not exceeding 20 m along existing

or new roads to inhibit access, if road is closed to traffic use. Plastic pedestrian barrier shall not be used next to deep excavations or steep falls where heavy pedestrian movement is expected. They shall be placed such that a minimum distance of 0.5 m space separates the plastic barricade and the excavated pit. Water-filled barricade shall be used if heavy pedestrian movement is expected.

Pedestrian Barrier



Mesh barrier



Fig. 6.2 Barriers



Fig. 6.3 Examples of Installations

6.4

Works on Footpath : Alternative Way for Pedestrians

An alternative safe route for pedestrians must be provided if it is necessary to close a footpath or part of a footpath as shown in **Fig. 6.4**. Additional equipment may be required to do this. Pedestrian access to property must always be ensured. Temporary pedestrian ways should never be less than 1 m wide and, wherever possible, they should be 1.5 m or more in width. It must be ensured that pedestrians are not diverted onto an unguarded carriageway. If the

temporary footpath is in the carriageway, the approach should be properly guarded and provided with signs. The lateral safety buffer clearance(s) must be on the traffic side of the pedestrian barriers. The signage and barricades should be in place before the footpath is blocked.

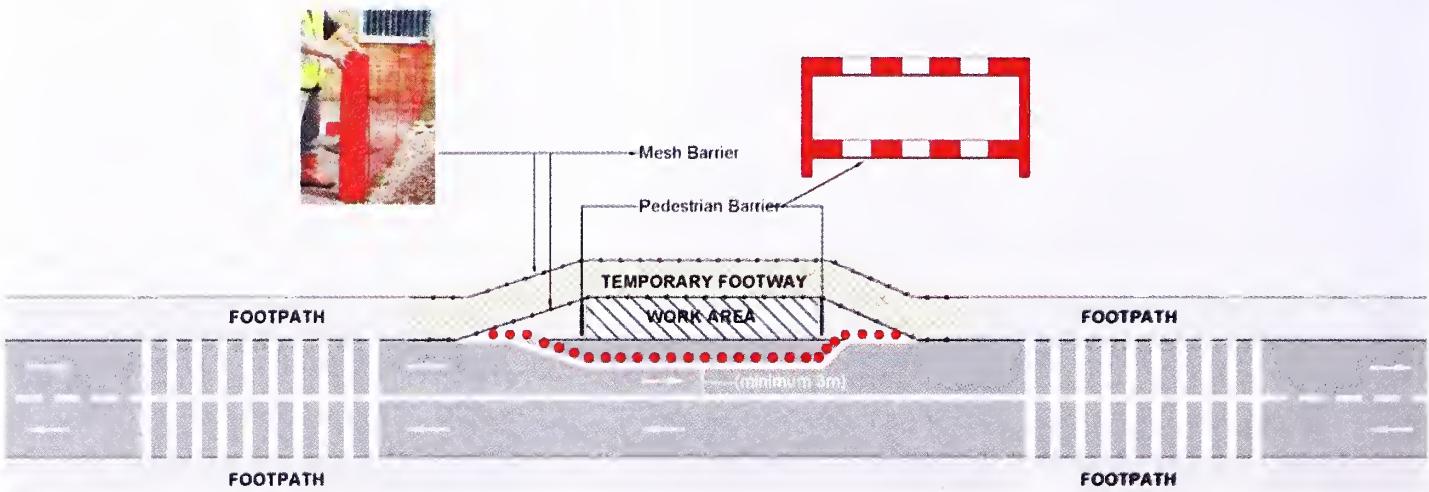


Fig. 6.4 Works on Footpath : Alternative Way for Pedestrians

In exceptional cases, the use of the other footpath may be acceptable in some quiet roads, but if this option is selected, the alternative route must be safe to use, and the needs of children and of people with disabilities must be taken into account.

6.5 Speed Reduction Measures

Most desirable speed reduction shall be by enforcement system using radar speed gun for violation of posted speed limit at the work zone. In urban roads and highways passing through urban areas, physical measures like speed breaker or raised rumble strip markings may be adopted. But they must be located after a careful assessment of the needs and most appropriate location. Such installation of speed breaker must be with adequate warning signs on approaches and proper lighting of the area for clear conspicuity of the speed breaker to approaching vehicles.

Speed breaker can be of various chord lengths which will permit different passing speed over the speed breaker (hump) as shown in **Fig. 6.5**. For construction of speed hump, the chord length can vary from 3 m to 9.5 m. In all cases the height shall be 100 mm only, and care shall be exercised to ensure that the height does not exceed 100 mm.

The raised rumble strip markings using thermo plastic paint or mastic sheets can be used with installation across the carriageway for deliberate reduction of speed in work zones in urban areas. The first application can be of 300 mm wide strips and second can be of 150 mm. These strips shall be provided at 500 to 1000 mm spacing's in a series/set comprising 15 to 20 strips at the distance of 130 m to 180 m from the start of work zone, for both directions of traffic, as shown in **Fig. 6.6**.

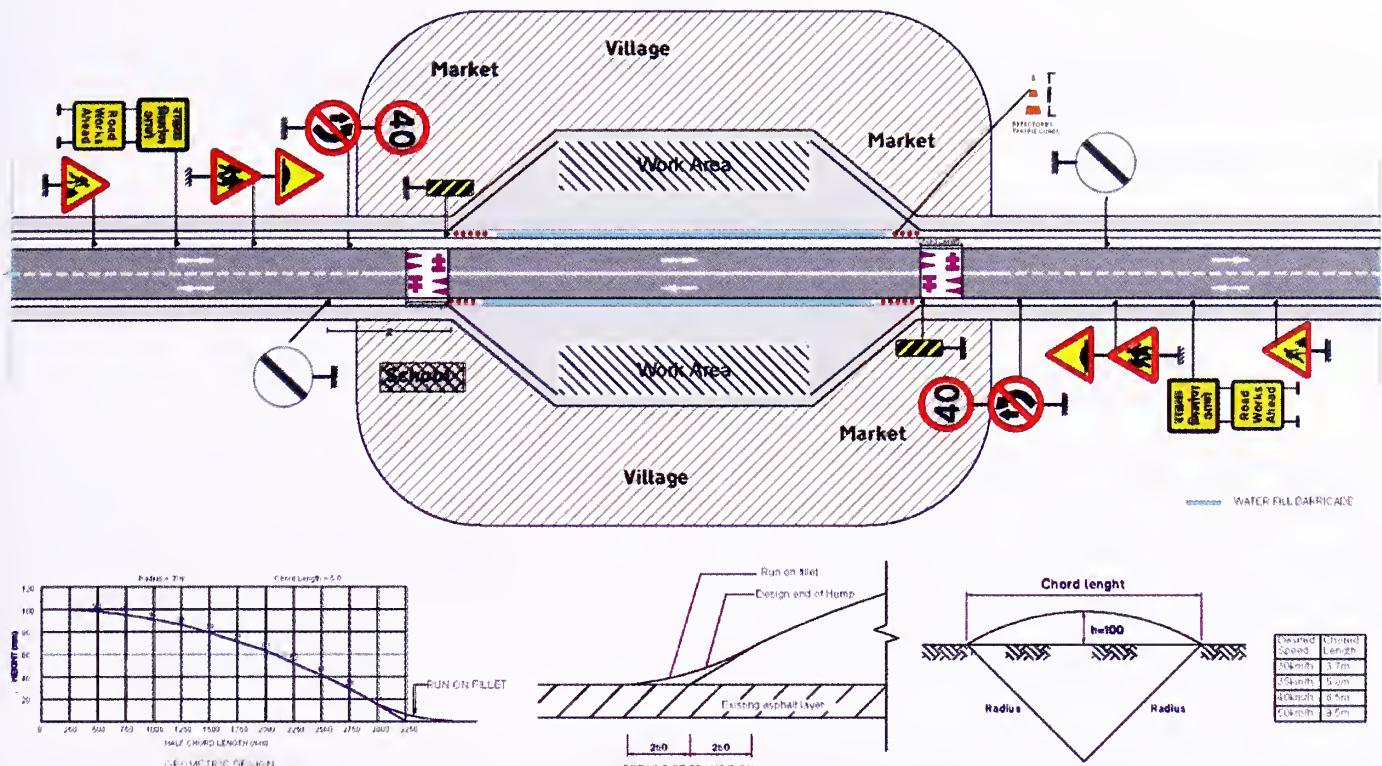


Fig. 6.5 Speed Breakers for Highways Passing through Urban Area

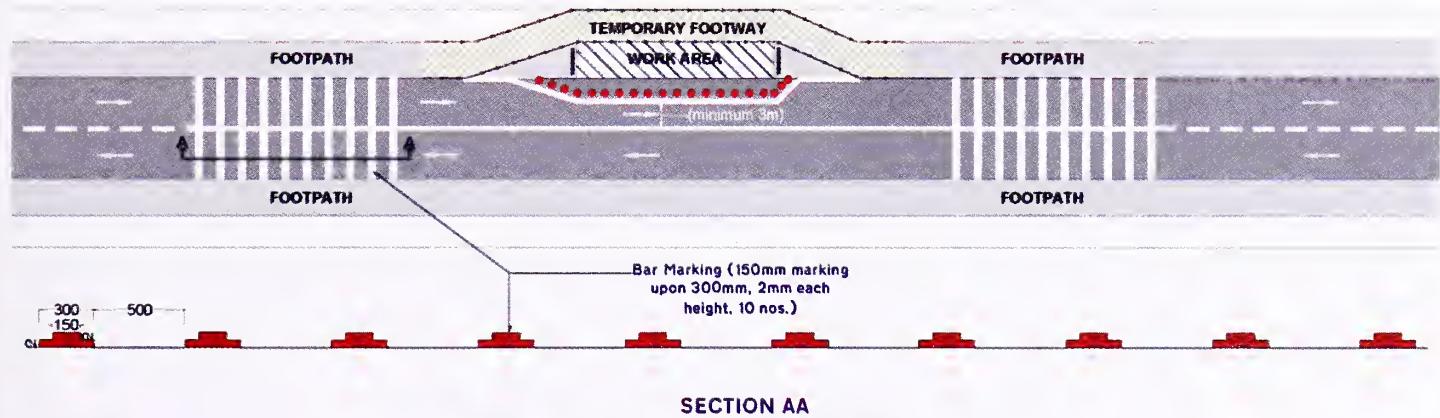


Fig. 6.6 Raised Rumble Strip Markings

These bar markings shall be removed upon completion of work at sites.

SECTION 7

TRAFFIC MANAGEMENT PRACTICES AT WORKSITES

7 Introduction

To manage the traffic flow through the work zone, a number of practices are available. Common practices are described below, and selecting the appropriate strategy is crucial to planning of WTMP for a safe work zone.

7.1 Alternate One Way Operations

The Alternate One-way operations can be put in place on a two lane bi-directional road; however this approach is suitable for very low volume roads. While one lane of travel is taken up with construction activities, the remaining lane is alternately used to accommodate traffic travelling in opposite direction. This strategy is generally limited to low volume roads, and requires at least two flaggers, or temporary traffic lights to safely handle the 'Stop' and 'Go' arrangement of traffic.

Different traffic control methods employed for alternate one-way operation are:

- "Give and take" system
- Priority sign
- "STOP/GO" boards or flags
- Portable traffic signals

When traffic in both directions must use a single lane for a limited distance, movements from each end shall be coordinated. Provisions should be made for alternate one-way movement through the constricted section via traffic control methods given below and choice of method depend condition shall be as per **Table 7.1**. The choice of traffic control method is governed by the following conditions,

Table 7.1 Choice of Traffic Control Methods

Traffic Control Methods	Maximum Speed Limit (kmph)	Length of Work Zone + Transition Zone (m)	Maximum Two Way Traffic Flow
"Give and take" system	50	50 m (max)	<ul style="list-style-type: none"> ● 400 veh/hour ● 20 commercial vehicle/hour
Priority sign	60	80 m (max)	850 veh/hour
"STOP/GO" boards or flags	60	100 m	1400 veh/hr
		200 m	1250 veh/hr
		300 m	1050 veh/hr
		400 m	950 veh/hr
		500 m	850 veh/hr
Portable Traffic Signal	60	300 m (max)	No limit

7.1.1 Traffic control by give and take system

Fig. 7.1 illustrates the Give-and-Take system of shuttle working. This is intended for low volume of traffic and very low volumes of trucks and no buses. The following conditions must apply:

- Total two-way traffic flow of less than 400 veh/hour;
- Less than 20 trucks/hour;
- Speed limit is 50 km/h or less
- Length of the works from the start of the lead-in taper to the end of the exit taper is not more than 50 metres
- Drivers approaching from either direction can see both ends of the site.

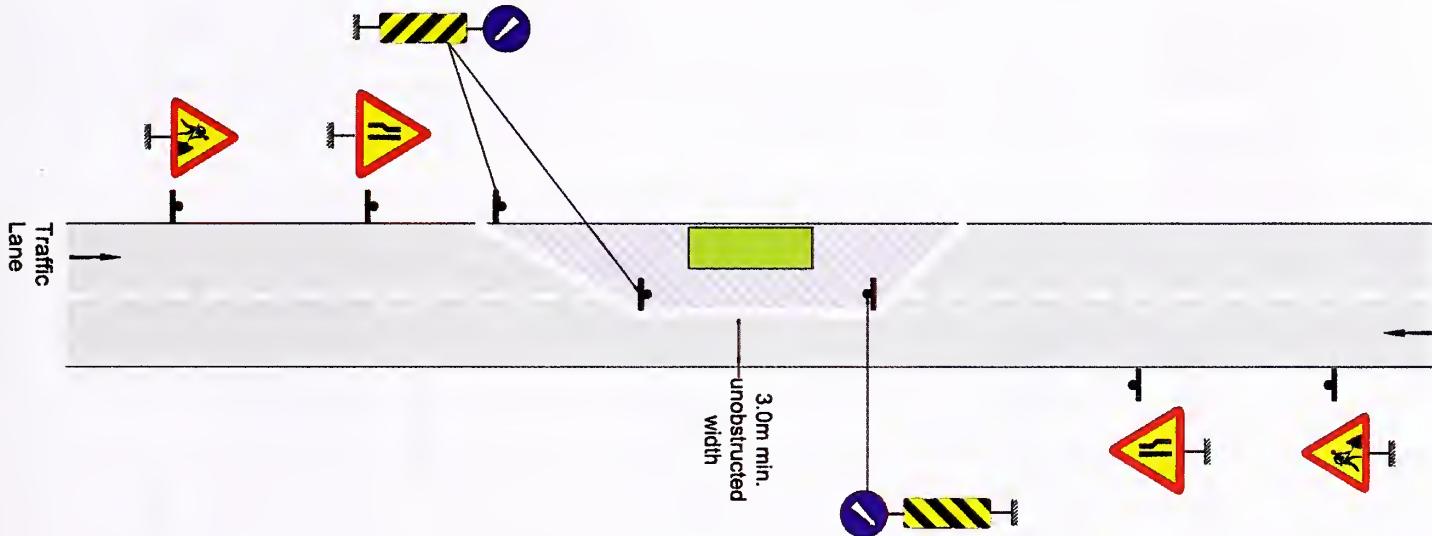


Fig. 7.1 Traffic Control by Give and Take System

7.1.2 Traffic control by priority signs

As flows and the difficulties of the site increase, enhanced systems are more effective. **Fig. 7.2** illustrates the next stage; under traffic control by priority signs the following conditions apply:

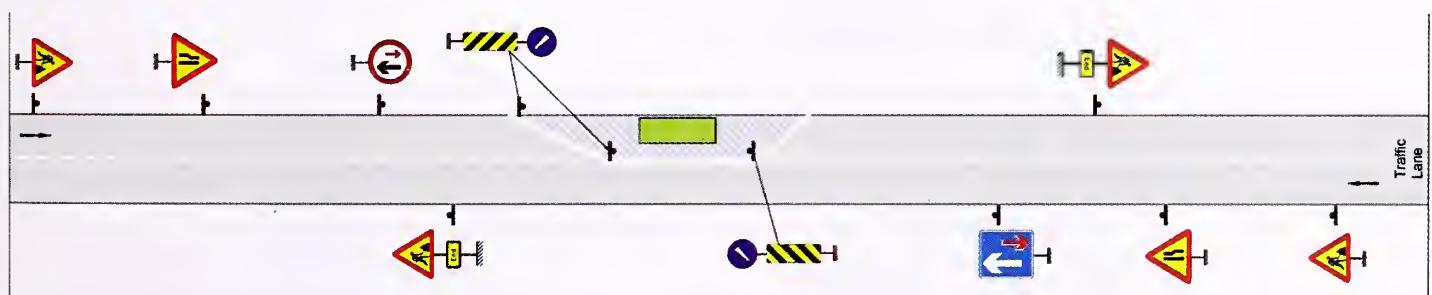


Fig. 7.2 Traffic Control by Priority Signs

- Total two-way traffic flow of less than 850 veh/hour
- Length of the works from the start of the lead-in taper to the end of the exit taper should not be more than 80 metres

- Drivers approaching from either direction can see through the site from a point 60 m from their transition zone to a point 60 m beyond their termination zone (coned area), for roads with a 50 km/h speed limit, on higher speed roads, the appropriate clear visibility distances are
- 70 m on 60 km/h roads;
- Not applicable above this speed limit.

In Indian conditions, its use is not recommended on higher speed roads.

- Priority must be given to either:
 - The unobstructed vehicle lane; or
 - Vehicles going up a steep gradient

7.1.3 *Traffic control by stop/go boards*

Fig. 7.3 indicates the layout for the use of Stop/Go boards by flagmen. Traffic can be controlled manually by using Stop/Go boards when the two-way traffic and the length of the site do not exceed the values given in **Table 7.2**.

Table 7.2 Maximum Traffic Flows for Length of Site

Site Length (m)	Maximum Two-Way Flow	
	Vehicles/hour	Vehicles/3 minutes
100	1400	70
200	1250	63
300	1050	53
400	950	47
500	850	42

Source : Safety at Street Works and Road Works, U.K., 2001.

7.1.4 *Traffic control by portable traffic signals*

- a) Portable Traffic Signals for traffic control **Fig. 7.4** can be used at most sites that have a length of 300 m or less. However, it should be ensured that the exit from the restricted length of road is not blocked. Otherwise tailbacks will occur which will stop traffic travelling in the opposite direction from moving when the lights change to green.
- b) Under no circumstances should portable traffic signals be used at works that straddle railway level crossings, nor to control road traffic within 50 m of a level crossing equipped with twin red light traffic signals.
- c) If it is considered that portable traffic signals used elsewhere may cause road traffic to block back to a level crossing, railway management must be consulted before work starts. The solution will probably be to move the traffic control to a point on the side of the crossing opposite the works so that traffic can be stopped before reaching the crossing. The portable traffic signals must be controlled manually. The crossing's own road traffic signals and advance warning and informatory signs should remain clearly visible to approaching vehicle drivers.

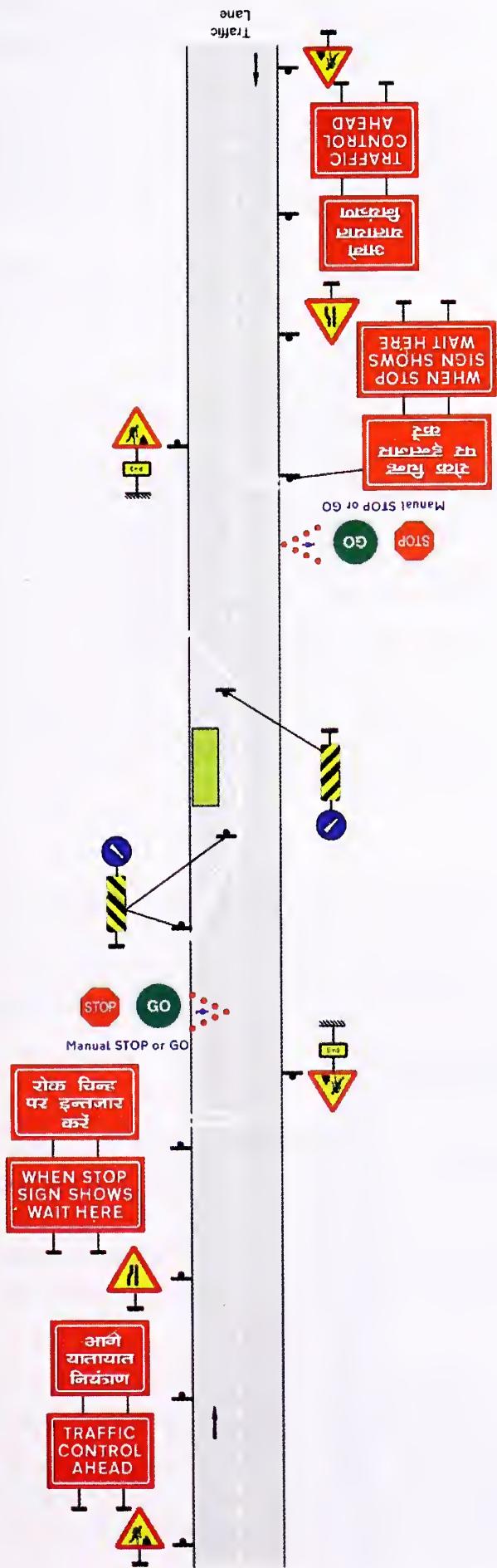


Fig. 7.3 Traffic Control by Stop/Go Boards

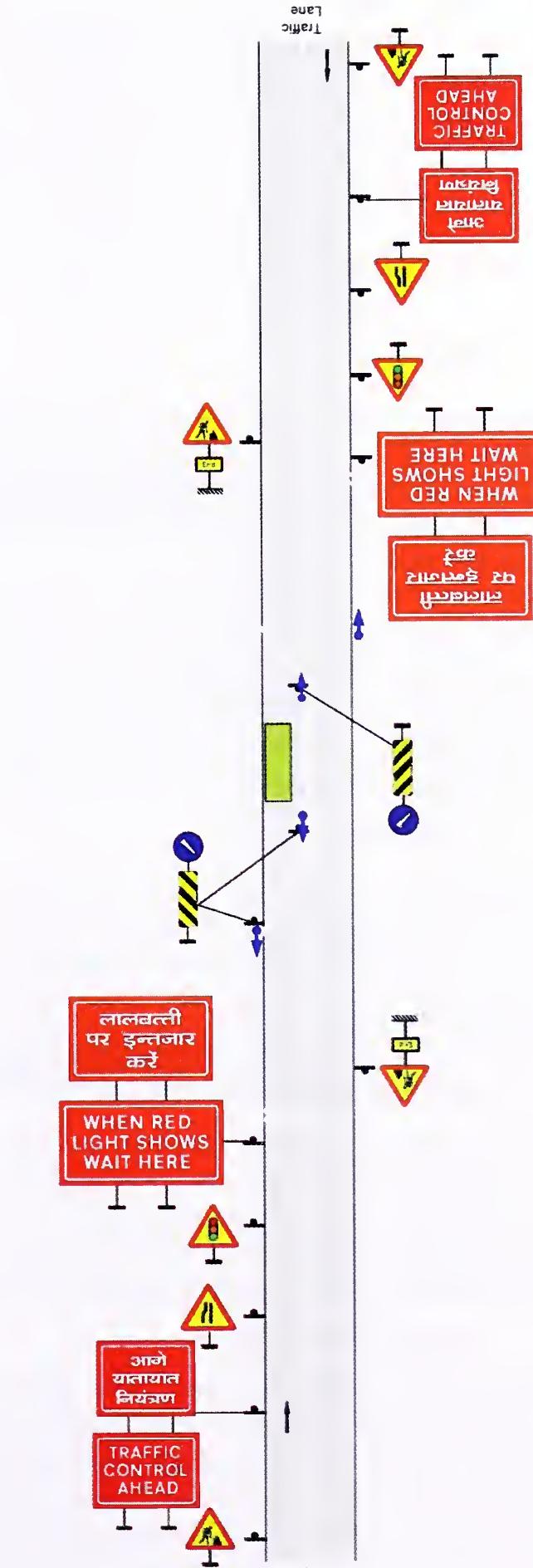


Fig. 7.4 Traffic Control by Portable Traffic Signals

- d) The road authority and traffic police must be informed when Portable Traffic Signals are going to be used. Authorization will be required if these signals are to be used at road junctions.
- e) The traffic signal timings must be correctly set up to correspond to the length of the works and the speed of the traffic past the site. The detectors must be tested, which are sometimes provided on the signals, to make sure that they are working properly before they are used.
- f) As back up, Stop/Go boards should be available in case the Portable Traffic Signals break down.

7.2 Detours

In this strategy, traffic is rerouted on to an alternate road and the traffic totally avoids the work zone. **Fig. 7.5** gives a detour situation. When traffic is directed from a road stretch under construction/improvement, to an alternative traffic route, construction operations can proceed rapidly. This can improve construction efficiency (i.e., reduce cost) and quality and ensure safety for the workers from passing vehicles. The detour can be applied for all categories of vehicles or applied to certain categories. Detouring traffic imposes additional capacity and load demands on the alternative route and may result in congestion. Safety considerations on the detour route should be considered as well, particularly if the detour route goes through areas with a large volume of vulnerable road users (residential areas, school zones, etc.). Detours should be carefully evaluated to ensure that they are capable of safely accommodating the volume and types (configuration, size, and weight) of detoured vehicles.

7.3 Diversions

The traffic in one or both directions is routed onto a temporary road constructed around the work zone and reconnected with the permanent infrastructure of the designated route. This provides positive separation between traffic and the work zone. Diversions can carry one-way or two-way traffic. This is especially useful in construction of bridges and culverts. The **Fig. 7.6** shows a temporary road for culvert construction.

7.4 Full Road Closures

Although dramatic, this strategy, if properly executed, leads to safe work zones, and reductions in work time such that the full closure is actually better in terms of delay. This can be effective and successful on road strategies with low, medium or high volume traffic. If a full road closure is chosen, whether it be short term or long term, the need for detours, as discussed above, must be weighed against the safety and operational benefits of the full road closure.

7.5 Intermittent Closures

With this strategy, traffic in one or both direction is stopped for relatively short period to allow for construction. This work zone strategy, alone, is generally not adequate for an entire construction project. It is more suitable for specific operations such as setting bridge beams, and moving construction machinery. Intermittent closure should be used for short duration (less than thirty minutes), outside peak periods and only during good weather conditions to minimize traffic disruptions and maximize safety.

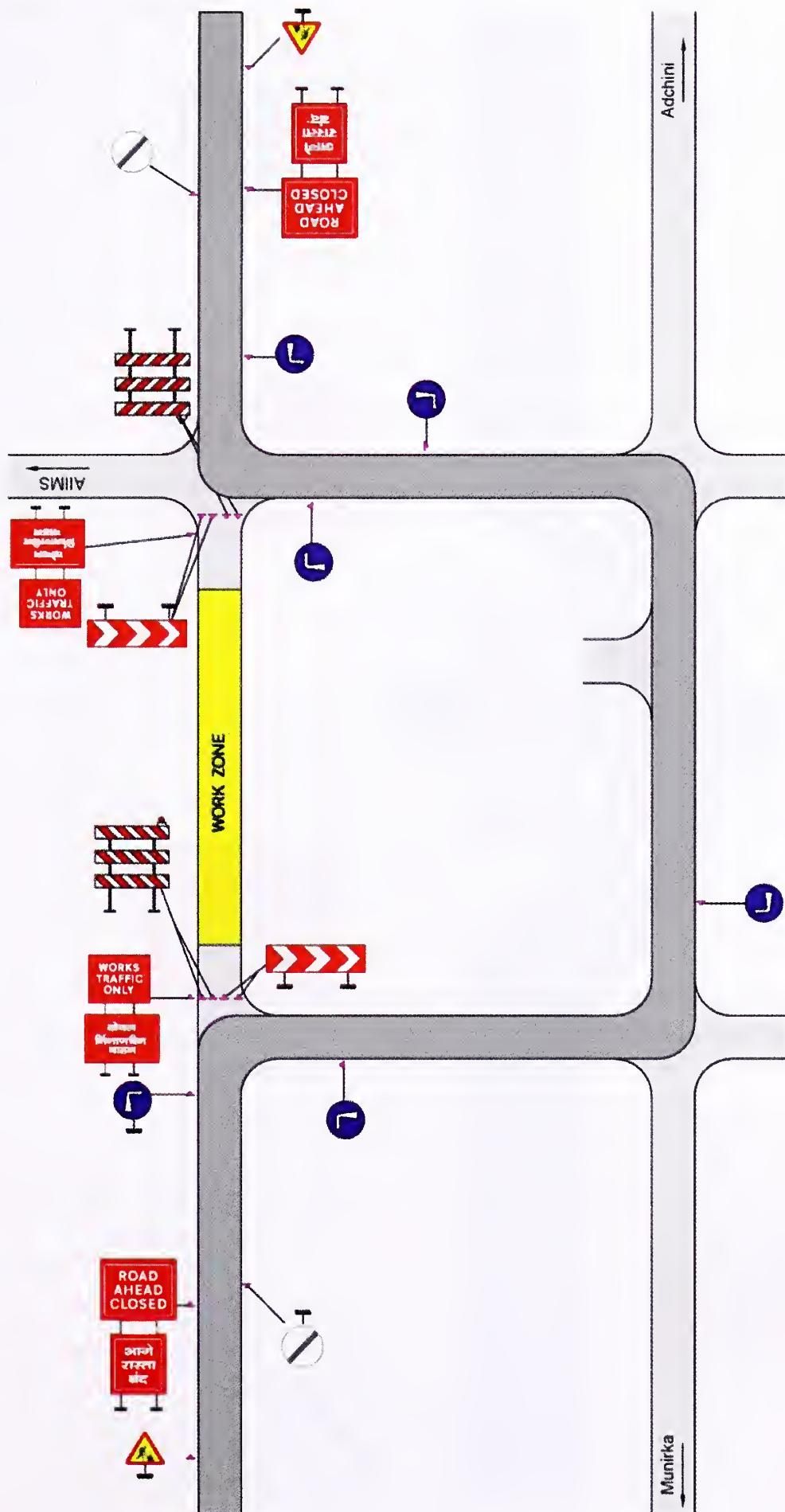


Fig. 7.5 A Detour Situation

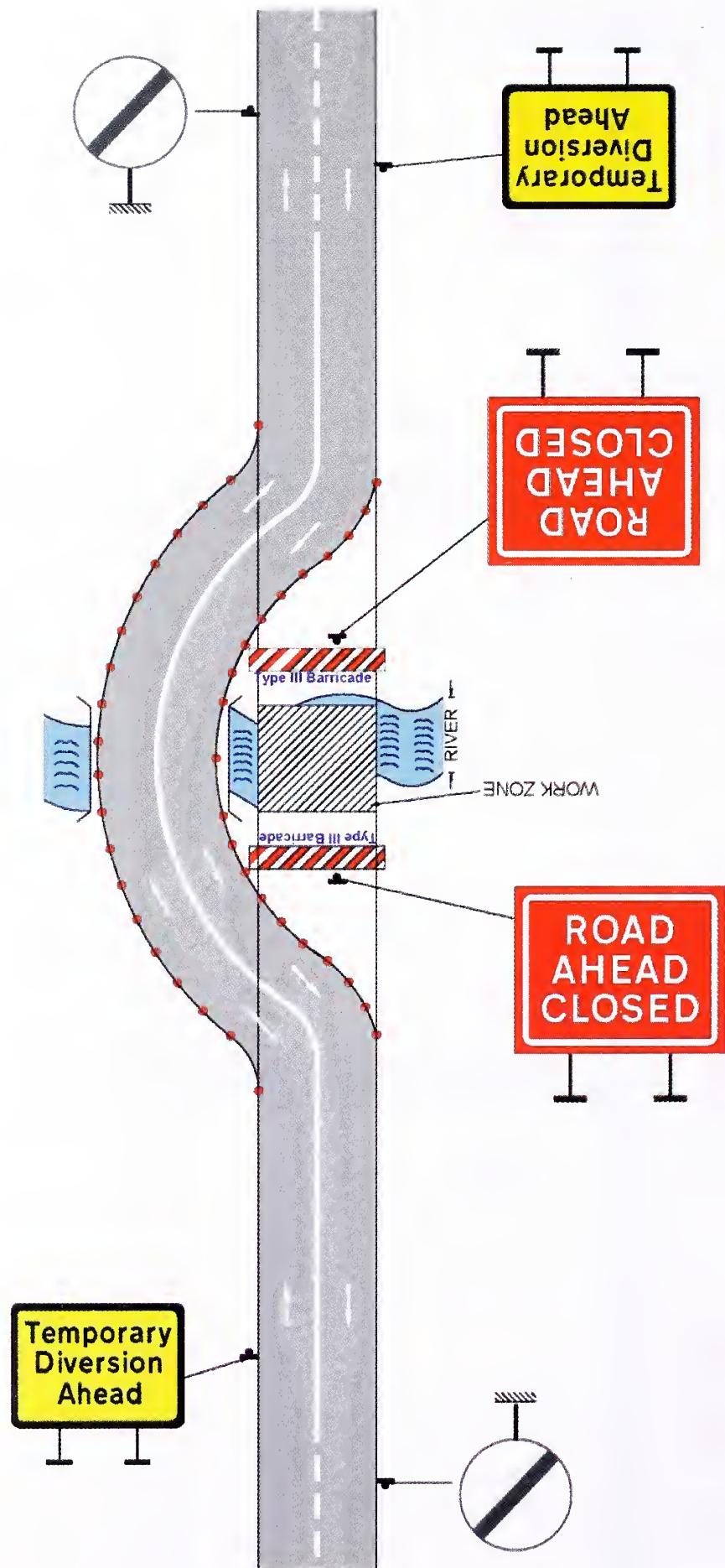


Fig. 7.6 Temporary Diversion

7.6 Lane Closures

In this strategy one or more traffic lanes and any adjacent shoulders are closed to traffic on one-lane of a multi-lane highway. When lane closures are used for long term projects, use of barriers should be considered, which can increase implementation costs. The strategy can be adopted for a short period (hours), if barriers are not provided.

7.7 Lane Constrictions

This strategy entails reducing the width of one or more travel lanes. This strategy should be adopted when maintaining traffic with less than desirable travel lane width is preferable to other alternatives. This can raise safety concerns, and therefore, reduced speeds are critical for this strategy to be successfully implemented. Refer **Fig. 7.7**.

7.8 Median Crossovers

This strategy is most suitable on expressways and divided carriageway highways whereby two-way traffic on a normally divided facility is allowed. A number of steps are necessary to implement this strategy including.

- Reducing the number of lanes in both directions of travel (lane closure);
- Routing traffic in one direction across the median to the opposite carriageway;
- Maintaining two-way traffic on one carriageway while the opposite direction carriageway is closed.

Substantial separation of traffic from the work zone is provided by this strategy and construction of an entire one-way carriageway (e.g., travel lanes, shoulders, structures, and appurtenances) is facilitated with little conflict between main highway traffic and equipment, workers, or onsite material movement. Traffic impacts in terms of speeds, queue formation, and delay should be assessed, and overall median crossover length should be carefully considered. Clearly this strategy is only used for long term road works.

While designing curves for median cross over, the radius given for various approach speed in **Table 7.3** can be adopted. The cross over length is depended upon the radius as well as the lateral shift as shown the **Fig. 7.8**.

Table 7.3 Radius for Setting out Cross Over Length

Speed at the Start of Diversion (kmph)	Radius of Circular Curve (m)
Up to 30	20
31 to 50	30
51 to 65	90
66 to 80	165
81 to 100	250
101 to 120	400

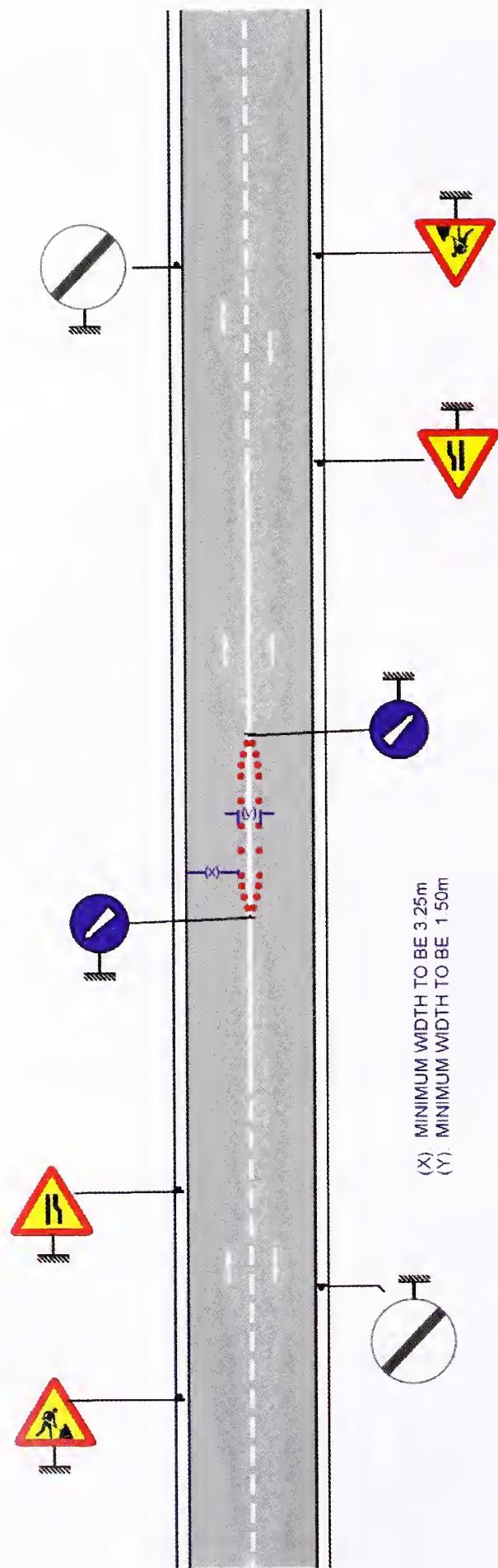


Fig. 7.7 Lane Narrowing due to work at Centre

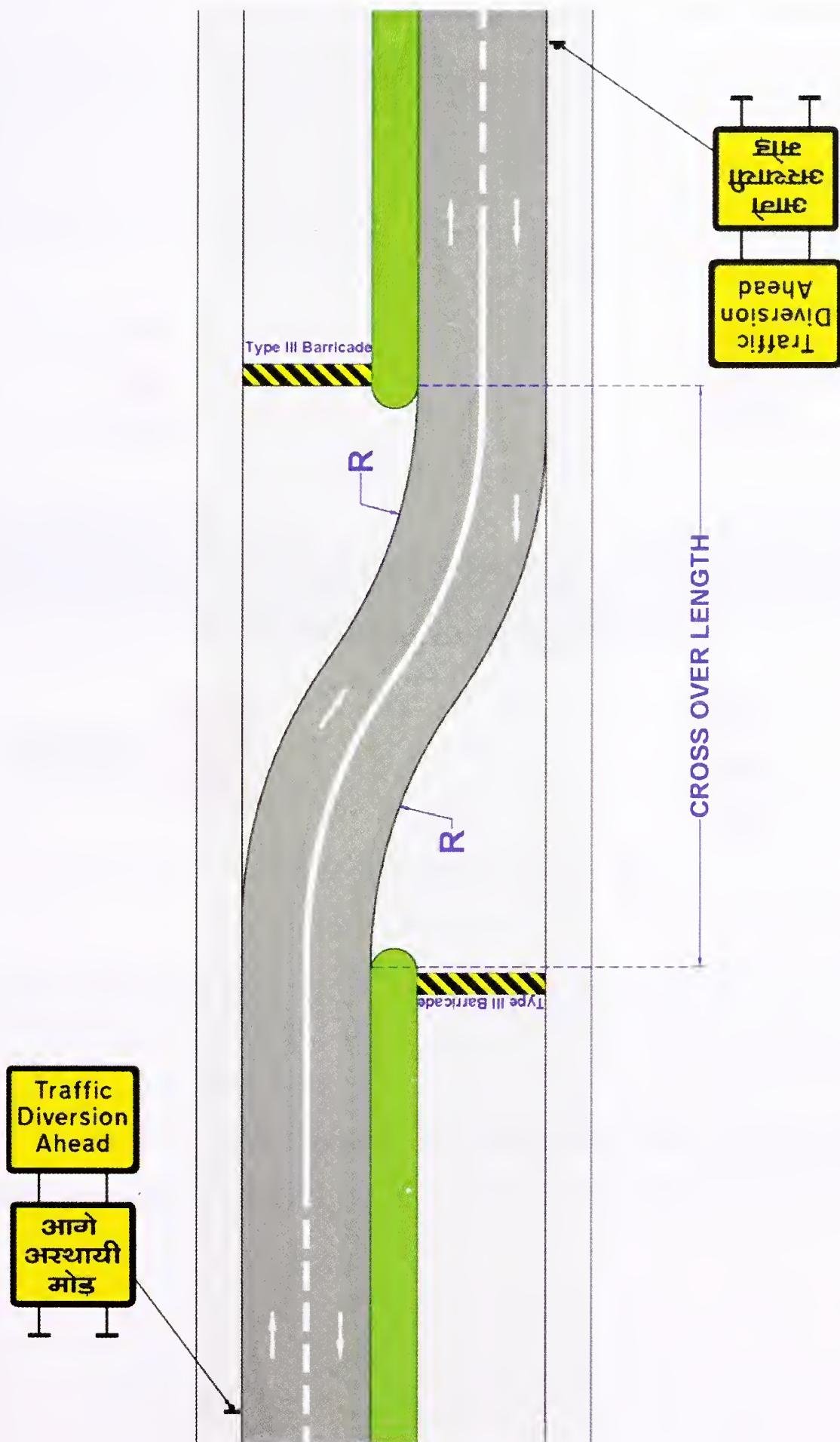


Fig. 7.8 Median Cross Over in Two-Lane Dual Highway Construction

7.9 Use of Shoulder as a Travel Lane

In this strategy, the outside or inside (median) shoulder is used as a temporary traffic lane. This strategy may require constructing or upgrading shoulder pavement structures to adequately support expected traffic loads. This strategy uses existing roadway width to compensate for the capacity lost by closing a permanent travel lane and can be adopted on facilities such as divided multilane, un-divided multilane and two-lane highway (Refer Fig. 7.9). The existence, proximity, and nature of roadside features (e.g., bridge piers) should be considered in assessing this strategy.

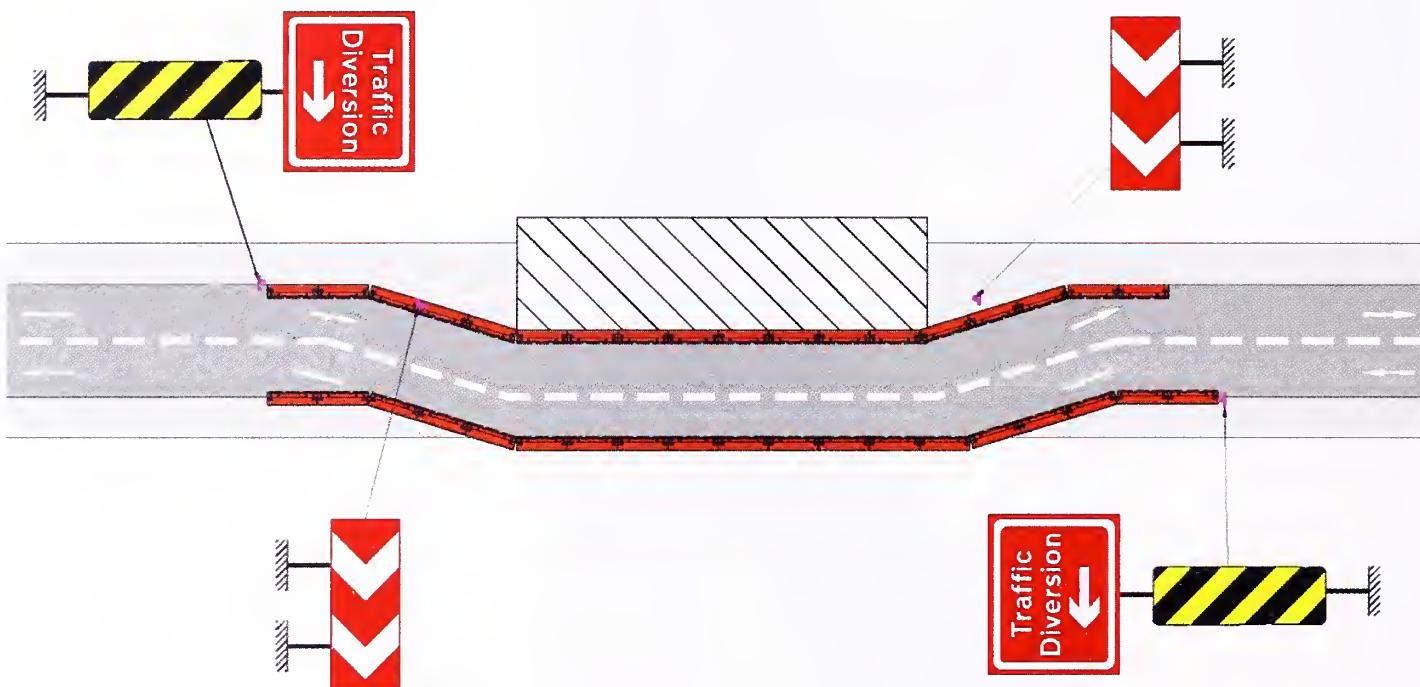


Fig. 7.9 Shoulder as Travel Lane

7.10 Night Construction

In many situations night construction may be preferred as the volume of traffic is generally lower and conflicts are minimized. Consideration must be given to the effect of night operations on the surrounding environment as well as the workers. Further, even if the work occurs at night, a lane or lanes may need to remain closed during higher traffic times.

7.11 Advantages and Disadvantages of Work Zone Design Strategies

The advantages and disadvantages of work zone design strategies are shown in **Table 7.4**.

Table 7.4 Advantages and Disadvantages of Work Zone Design Strategies

S.No.	Strategy	Summary	Advantages	Disadvantages
1)	Alternate one-way operations	Mitigates for full or intermittent closure of lanes. Used primarily with two lane facility.	Low agency cost; flexible several variations available.	Requires stopping of traffic reduces capacity.
2)	Detours	Reroutes traffic onto other existing routes/facilities of the network.	Flexible: cost varies depending on improvements to detour route.	Usually reduces capacity; detoured route may require improvement for capacity and safety.
3)	Diversions	Provides a temporary roadway adjacent to construction.	Separates traffic from construction; reduced impact on traffic.	Cost may be substantial.
4)	Full road closures	Closes the facility to all traffic for a specified duration.	Generally also involves expedited construction; separates traffic from construction.	Potentially significant traffic impacts.
5)	Intermittent closures	Stop traffic for a short period	Flexible and low agency cost.	Useful only for activities that can be completed in short time.
6)	Lane closures	Closes one or more travel lanes.	Maintains service at fairly low agency cost if temporary barriers are omitted.	Reduces capacity: may involve traffic close to active work.
7)	Lane constrictions	Reduces width of travelled way.	Maximizes number of travel lanes.	Travelled way width is less than desirable: may involve traffic close to active work.
8)	Median crossovers	Maintains two-way traffic on one carriageway of a normally divided highway.	Separates traffic from construction: right of way not required.	Relatively costly; interchanges need special attention.
9)	Use of shoulder as a travel lane	Uses shoulder as a travel lane.	Fairly low cost depending on shoulder preparation.	Displaces traditional refuge for disabled and emergency vehicles: cross slopes may be problematic.
10)	Night Construction	Move work activities to night time hours.	Lower traffic volume or lower traffic impacts.	Higher agency cost; disruption of social pattern of workers; Noise pollution.

SECTION 8

ROLES AND RESPONSIBILITIES

8.1 Introduction

Many agencies and professionals are involved in the safety of a work zone and to avoid confusion, it is helpful to clearly define their roles and responsibilities. Roles describe the proper and customary functions of each player, while responsibilities are linked to the obligations of that party including funding of the provisions. All the necessary responsibilities must be assigned and completed without which the safety of the work zone will be compromised.

By clearly defining the roles and responsibilities addresses the critical issues of **who** must do **what** and **when!** Furthermore, these concepts allow to clearly defining where the responsibility lies, and assists in ensuring that important safety issues are not overlooked at any time.

8.2 Critical Players or Stakeholders

Critical players in road construction and maintenance activities are:

- Road Authority
- Road Operator
- Project Director/Engineer In-charge
- Designers
- Road Safety Auditors
- Concessionaire in PPP projects
- Contractor
- Supervision Consultant/Independent/Resident Engineer
- Local Police
- Road User
- General Public/Communities

8.2.1 *Road authority*

The Road Authorities with the support of politician's and/or decision/policy makers must support and demand:

- responsible work zone planning and design from transportation professionals;
- safe behaviour within the work zone from the workers; and
- Safe driving behavior through the work zone from the travelling public.

Political support and commitment is crucial in the supervision and enforcement of standards in road works, otherwise, even the best designs and plans cannot logically provide for the safety of road users and workers.

Road Authorities should support appropriate legal and safety requirements, standards and regulations for work zones and clearly establish the responsibilities of parties involved. They would ensure that other Agencies, such as local police and local administration etc. share and act in accordance with the requirements of WTMP. The authorities are also responsible, in the long run, for ensuring that sufficient funding is provided not only for safety in work zones, but for overall road safety. The authority is also responsible for educating and informing the public about safety in work zone so as to promote responsible driving, through outreach and safety campaigns. The Road Authority shall ensure that the provisions for all traffic control devices of WTMP are included in the Bill of Quantity (BoQ) while preparing the estimate for projects taken up under PPP or non-PPP modes of implementation.

8.2.2 *Road operator*

The road operator must insist that the legal and safety requirements, standards and regulations for work zone safety that have been established by the authorities are complied in letter and spirit. The Road Operator shall ensure that Work zone Traffic Management Plan has been prepared before taking up the work of building and or improving the road and being implemented effectively. If necessary, the road operator may demand additional requirements that should be in writing and publicly available. These additional demands regarding safety and traffic management issues include:

- Requiring additional safety equipment such as barriers for worker's safety, channelizing traffic flow, traffic guidance, and additional signs (with clearly defined sizes and colors prescribed in these Guidelines and based on the traffic environment);
- Defining set of working hours, like 24 hours or 12 hours on busy roads (depending on the level of technology used in the process of work);
- Maximum length of detours and minimum requirements or condition for determining if a bypass is needed; and
- Requirements for the roadway that will be used for detour (including design and pavement standards and capacity requirements to ensure that safety is not compromised).

Before beginning the road works, the road operator in coordination with the contractor/concessionaire (for PPP projects) as the case may be, must inform the public and residents of the location, about duration and possible deviation and time of road closure. Police and emergency services should also be fully engaged in understanding where and how a work zone is being implemented, along with the type of work being done and any detour, etc. that are planned.

The road operator can demand that the contractor (or whoever requires a work zone to implement their work, such as the laying of cables, pipes, utilities, etc.), design and implement a safe work zone and use all necessary means to ensure safety for workers and road users, as well as sufficient traffic capacity. The operator may ask the contractor to take on the

responsibility for informing the general public and surrounding community of important information such as the work zone location and duration, the access issues, possible detours and other means of travelling through the area.

A variety of methods should be considered to inform the general public and surrounding community, including media (radio, TV, newspaper, websites) or through public gatherings or hearings. The permission of the road operator must be gained for any intervention along the roadway, including issues related to access management. Thus, the road operator will order the contractor to design and implement a safe work zone. The road operator can request that the supervisor pay particular attention to a work zone that is particularly complex, demonstrates clear risks, or has a history of accidents or incidents.

8.2.3 *Project director/in-charge*

The Project Directors/In-charge shall be responsible for overseeing and ensuring adherence to the norms/guidelines and contractual provisions required to be complied with by the consultants and the contractors/concessionaires. He would review the site specific WTMP prepared and ensure its implementation effectively.

The Project Director may designate one of the officers from his team, to be responsible for safety besides environment and social aspects.

8.2.4 *Designer*

The “approved” designer should be a company (or individual) that has expertise and knowledge of (and, if appropriate, certification in) work zone design and safety issues. The designer’s primary responsibility is to include all required provisions in the design to ensure traffic safety for road users and workers. The designer should alert the road operator to key issues with regard to safety.

The designer will be responsible for ensuring that all technical solutions are described and can be implemented in accordance with the appropriate laws and standards. The designer will be the legally responsible party for the work zone layouts. The designer must:

- Gather all necessary information on traffic volume, traffic mix, and types of road users that are expected;
- Understand technical elements of the site of the work zone, as well as roads that might be used for detours/diversions/bypasses;
- Coordinate and manage detours;
- Consider road signs and markings, including existing permanent signs that might need to be removed or covered as well as to provide necessary work zone signs;
- Harmonize the technical and scheduling aspects of the work zone with regard to implementing, managing and removing the work zone; and
- Identify the necessary lighting of the work zone, if night works are being considered.

The designer should develop a work zone that allows emergency vehicles sufficient access and passage of transit vehicles. If a road is closed and emergency vehicles must use a detour, the designer should provide that information in writing. Furthermore, transit agencies should be informed in advance before detours are established so that they can plan their trips and stops. The designer is likely to take on the responsibility of participating in public hearings or community outreach meetings to explain the work zone to the community.

8.2.5 *Road safety auditors*

The road safety auditors shall be independent of design and execution process and will carry out safety audits to identify the potential safety deficiencies in the Work zone Traffic Management Plan (WTMPs) at its design stage. The observations and safety concerns along with specific recommendation will be forwarded by the road safety auditors to the Road Authority, Road Operator, Concessionaire, and contractor as the case may be. The road safety auditors while undertaking the field audit will come up with recommendations which are either due to non-compliance of approved WTMPs or sometimes due to distortions in the traffic control devices caused by poor maintenance regime for WTMPs. Since the deficiencies observed by safety auditors have direct impact upon the safety of road users and construction workers, the recommendations made by the auditors shall be complied without fail. On the other hand, the road safety auditor shall be liable for any irresponsible recommendations made through worksite safety audit report, which are illogical and are not suitable for site condition or not approved at the time of design of WTMP.

8.2.6 *Contractor*

Contractor has a contract with the road operator to execute the work zone and conduct the work. He is responsible for preparation of WTMP and for coordinating with the designer to ensure that they understand how the work zone should be set up and operated over the course of the works. If the contractor is not qualified to install, operate, maintain and remove the work zone, then they must hire a special contractor which is qualified for these critical activities.

An expert on safety or an engineer trained on work zone safety from a qualified company should be named to implement the work zone, including installing, operating, maintaining and removing the work zone. The work zone must be checked daily (or more frequently, if necessary) to ensure it meets the designer's scheme. Daily meetings should take place to ensure that all workers and staff are knowledgeable on the work zone activities and damaged equipment must be immediately replaced.

It is contractor's responsibility to qualify and train the workers and ensure that they have the necessary safety equipment (see **Section 7**). Those working on roads in the presence of operating traffic should have proper knowledge and training and should wear high visibility clothing with light reflecting material. Those managing the traffic flow (flaggers) should have

knowledge on guiding of traffic and (if appropriate based on national standards) be certified. In general, all workers should have proper knowledge and be trained about how to avoid risks and maintain work safely; and the contractor is responsible for ensuring that the workers have that knowledge.

8.2.7 *Concessionaire*

For PPP projects, the Concessionaire shall observe his obligations, responsibilities and requirements as spelt out in the Model Concession Agreement (for road sector) as well as in the Concession Agreement, during the design, development, construction, operation and maintenance. He shall ensure that safety of road users and workers remains the paramount consideration in planning and executing the project implementation, and findings of the deficiencies by Safety Auditor are promptly rectified.

For PPP projects, the Concessionaire shall prepare detailed layouts for temporary traffic management plan (WTMP) with all traffic control devices and submit to the competent authority as per the Concession Agreement for their review and approval before taking up works on the ground.

8.2.8 *Supervision consultant/independent/resident Engineer*

The Supervision Consultant/Independent/Resident Engineer must have a highly trained road safety expert. They must be officially approved and certified through the relevant institute or agency for conducting trainings on work zone safety.

He should have responsibility to the agency hiring them (the authority, the road operator or the contractor) to check the work zone design and to ensure that it is implemented in a way that safety needs are realized.

He will check the actual work zone to ensure that it is set up (signs, markings, and other equipment) consistent with the approved design of WTMP and

- It is consisted with legal requirements; and
- It provides safety for road users and workers.

If it is found that the design is deficient, he or she should advise the designer to make the necessary design improvements. If the actual work zone is not set up in accordance with the design, the supervisor should ask the contractor to make the necessary changes.

He should coordinate with local police to pay extra attention in work zones, with particular emphasis on vehicle speeds.

8.2.9 *Local police*

Local police shall provide all the required support for the enforcement of the necessary restrictions, if imposed, and for the safety measures as warranted by WTMP. The control for speeding and careless driving in work zones should be strictly enforced.

Road user

All road users need to pay particular attention while travelling in work zones. Drivers need to appreciate and respect that workers often have very little physical protection from fast moving vehicles that are travelling past their place of work. They should drive in such caution that they do not pose a threat to other traffic or to workers. Drivers should be educated about the risks of travelling in work zones and fully informed that safe driving behaviors will be strictly enforced by the police. They shall respect and observe any restriction, especially for speeds.

8.2.10 *General public/community*

The community has a responsibility to participate in public hearings and be informed about work zones, detours, and possible transportation options. As they have the best knowledge of their environment, they can contribute to improve work zone safety by providing information about the situation, especially with regard to detours.

SECTION 9

DEPLOYMENT OF PERSONNEL AND SAFETY COMPLIANCE

9.1 Introduction

Many individuals are involved in the safety of a work zone and to avoid confusion, it is advisable to deploy the specific and assigned personnel for controlling the traffic during the peak and off-peak hours of traffic flow at the construction zones.

9.2 Deployment of Flagman

The flagmen or flaggers shall be deployed where:

- Workers or equipment intermittently block an unprotected traffic lane
- One lane is used for two direction of traffic
- Guidance, warning and control of traffic is considered necessary

The flagman shall be physically fit, well trained, alert and capable enough to effectively perform the assigned duties. Flagman shall be provided with hand signaling devices such as flags and sign paddles. Flagmen must be provided with and must wear warning garments, safety headgear, footwear and gloves for their protection and for conspicuity, while flagging. Warning garments worn at night must be of reflective material. Flags for signaling shall be minimum 600 mm x 600 mm in size and made of good red cloth and securely fastened to a staff of approximately 1 m in length. Sign paddles should be at least 600 mm wide provided with a rigid handle. The background color of STOP should be red and its shape shall be octagonal conforming to IRC:67-2012. The word STOP would be in white colour. Similarly, the background of SLOW sign should be yellow with black letters, and the GO sign shall be with green background with white letters.

The control of traffic through work area is an essential part of road construction and maintenance operations. Flagmen with hand signaling devices such as sign paddles play crucial role in this context. STOP, SLOW and GO paddles are used, and in some cases temporary traffic lights are used in controlling traffic through work area.

- a) Besides red and green flags, octagonal and round shaped hand paddles of 600 mm x 600 mm should be used with red, yellow and green retro reflective Class B sheeting as per IRC:67-2012, if used in nighttime, whereas red and green flags can be of visible fabric materials for daytime usage.
- b) Since, Flagmen are responsible for safety of road users and the workers, it is important that qualified personnel be selected. The flagmen at the work sites are expected to stop traffic intermittently and to maintain continuous traffic flow at work site at reduced speeds to help protect the workmen. For both of these functions, the flagmen must, at all times be clearly visible to approaching traffic for a distance sufficient to permit proper response by the

drivers to the flagging instruction and to permit traffic to reduce speed before entering the work site. This distance is basically related to approach speed and site conditions; however 60 m to 100 m is desirable. In urban areas, this distance shall be reduced to 20 m to 50 m. The use of sign paddle is illustrated in **Fig. 9.1**. Other modern method is Marshalling torches as shown in **Fig. 9.2**, and are

- i) Hand flashers are tough and durable working on normal or rechargeable batteries with LED bulbs.
- ii) To provide warning signal for impending hazard or danger on construction work zone, repair sites, trenches, digging of road tunnels etc.

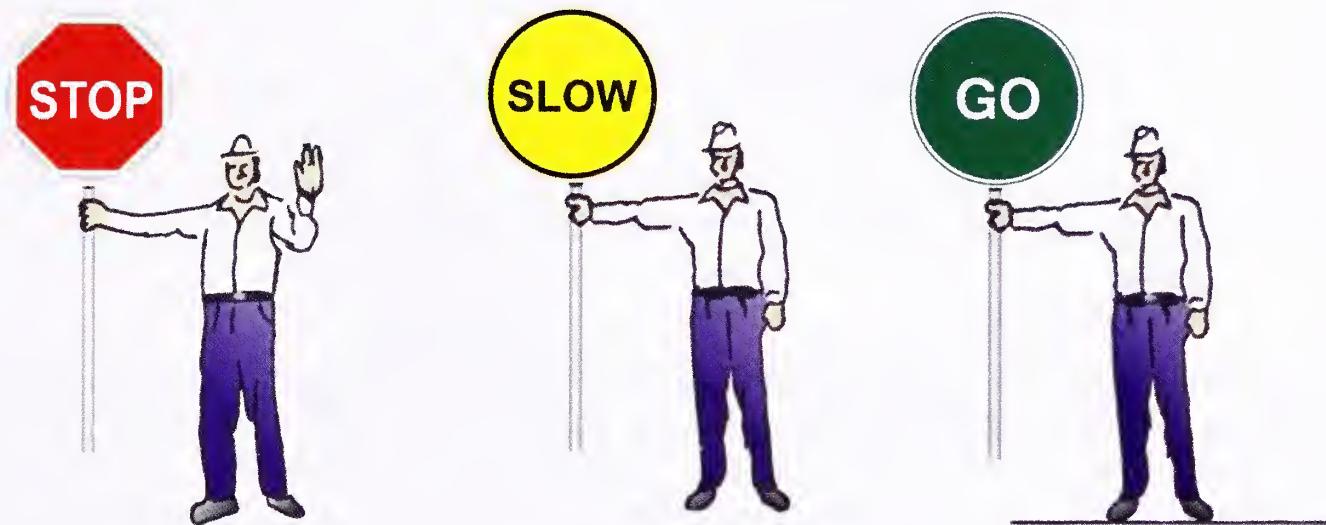


Fig. 9.1 Warning Sign on Hand Paddles



Fig. 9.2 Marshalling Torch

9.3 Reflective Clothing

In the work zones and construction sites, all the workers, supervisors and inspecting officers shall wear high visibility fluorescent clothing with retro-reflective material, so that their presence is conspicuous from a distance of even 100 m. Clothing may be in form of vests, T-shirts,

jackets, pants and raincoats etc., depending upon weather conditions and ease of usage. The suggested colour to be used for the safety jackets shall be as given in **Table 9.1**.

Table 9.1 Colour of Safety Jacket

User	Colour of Fluorescent Jacket
Workers exposed to traffic	Red - Orange
Operators of road construction machineries	Orange
Supervising engineer and visiting higher officials	Yellow

The reflective clothing shall have reflective bands of width appropriate for the garments, viz. vests, T-shirts, jackets, pants and raincoats. It shall have 360° visibilities with at least one retro-reflective band encircling the torso. There shall be appropriate separation distances of vertical and horizontal bands placed on torso, sleeves and trouser areas. The garment shall be free of roughness and sharp edges so as not to cause excessive irritation and the wearer should get the best possible degree of comfort and protection. The reflective clothing shall meet the requirements of standards set up in IS:15809-2008 or EN 471:2003.

9.4 Roll Up Signs

Roll up signs are used in construction work zones to guide the traffic and in roadways for meeting emergency situations. Roll up signs shall be portable, changeable and shall have provisions for application on different objects depending on the need for temporary sign. Such sign shall be made of retro-reflective sheeting, which shall conform to Class B as per IRC:67-2012.

- a) Mounting of the roll up sign on the portable stand

The roll up sign shall have the back support ribs to fix on the portable stand and the roll up sign stand shall have knobs to receive the short rib of the sign fascia. The back support ribs shall be inserted in to the clamp provided on the stand and tightened using the knobs. The sign ribs shall be moved up and down to adjust the height of the sign.

- b) Mounting of the roll up sign on construction or maintenance vehicles

The roll up signs shall have necessary attachments to mount it on the work zone maintenance vehicles. The back support ribs shall have dual lock high bonding tapes; mechanical fastening or snap fit clips or attached magnets. The receiving part of dual lock tape, clips or metallic attachment shall be pasted on the vehicle surface where the roll up sign needs to be mounted.

The sign mounting mechanism shall withstand the weight and movement of the vehicle.

c) Mounting of the roll up sign on barricades

The roll up signs shall have necessary attachments to mount it on Barricades. The ribs at the back side of the signs shall have a dual lock high bonding tapes or a mechanical fastening system which can be removed and re applied multiple times. The receiving part of the tape of fastener shall be applied on the barricade. The locking portion of the tape or the fastener shall be permanently fixed on the ribs of the roll up signs. Shown in **Fig. 9.3.**

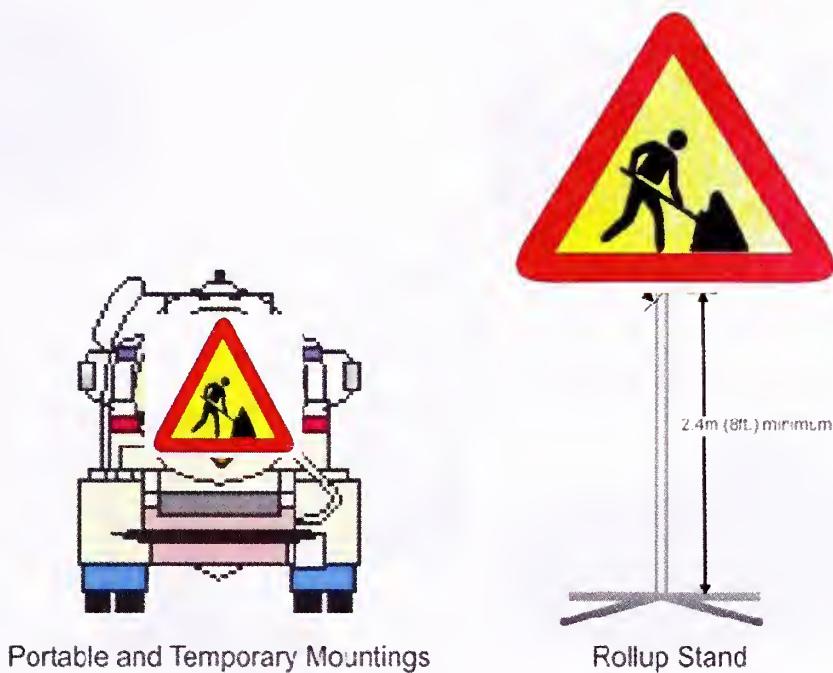


Fig. 9.3 Temporary Installation of Signs on Maintenance Vehicle & Roll up Stand

9.5 Protective Gears for Workers

All the workers, exposed to moving roadway traffic or equipment in road construction zones shall wear high-visibility safety apparel, headgear, boots, gloves and protective gears for their protection. The safety headgear or protective helmet shall protect the wearer against falling objects and possible serious injury. It shall address requirements of shock absorption, and having resistance to penetration, flame resistance, chin strap anchorages, comfortable wearing and shall meet the requirements of Bureau of Indian Standards (IS:2925). The safety shoes or boots shall provide personal protection from any possible hazard posed by the activity being done and provide comfortable wearing without giving any hindrance in the expected tasks. The work gloves shall provide protection against any personal injury that could be caused by the activities to be performed and comfort in wearing without giving any hindrance in the expected tasks. If the worker is to be exposed to dust in the work zone, he shall have respiratory protection by dust mask meeting the requirements of IS:9473-2008. Depending upon the task, workers engaged in welding operations shall have eye protection through passive welding sheet meeting the requirements of EN 175 or auto darkening sheet

meeting the requirement of EN 379/EN 169. Some illustrative safety jacket, head gear, and foot-wear for workers are shown in **Fig. 9.4**.



Fig. 9.4 Illustrative Safety Jacket, Head Gear, Foot-Wear for Workers

SECTION 10

TYPICAL APPLICATIONS

10.1 Introduction

Some typical construction scenarios are presented in the section to serve as guide in preparing site specific Work Zone Traffic Management Plans (WTMPs). The signs, markings and traffic control devices shown herein are indicative only and more are required to be added to cater to the specific road environment and road users likely to use. Highway and Traffic Engineers are required to prepare WTPMs and if required, advice of road safety expert may be sought for this.

10.2 Typical Layouts

Following commonly occurring situations are presented in drawing format, but are not the only ones.

- Fig. 10.1 : Two Lane to Four Lane (Eccentric Widening)
- Fig. 10.2 : Two Lane to Four Lane (Shifting of Traffic from One Carriageway to Other)
- Fig. 10.3 : Two Lane to Four Lane (Concentric Widening)
- Fig. 10.4 : Two Lane to 4-Lane/6-Lane (Concentric Widening)
- Fig. 10.5 : 2-Lane to 4-Lane – Concentric Widening
- Fig. 10.6 : Four Lane to Six-Lane (Concentric Widening)
- Fig. 10.7 : Four Lane to Six Lane – Concentric Widening
- Fig. 10.8 : Stage-1 of Upgrading Single/Intermediate Lane Road to 2-Lane with Shoulders
- Fig. 10.9 : Stage-2 of Upgrading Single/Intermediate Lane Road to 2-Lane with Shoulders
- Fig. 10.10 : Temporary Diversion for Reconstruction of CD Works
- Fig. 10.11 : Roadwork in Junction Area
- Fig. 10.12 : Work at Center of Carriageway
- Fig. 10.13 : One Direction for Major Work at the Centre of Road
- Fig. 10.14 : Road Work with Detour/Bypassing
- Fig. 10.15 : Stage-1 of Flyover/VUP Construction
- Fig. 10.16 : Stage-2 of Flyover/VUP Construction
- Fig. 10.17 : Fast Lane Taken up for work
- Fig. 10.18 : Roadwork Affecting Both Carriageways of Expressway

- Fig. 10.19 : Road Work at the Centre of a Junction
- Fig. 10.20 : Road Work at the Corner of a Junction with Temporary Signal Control
- Fig. 10.21 : Road Work at Roundabout with Constricted Circulatory Carriageway
- Fig. 10.22 : Road Works at Level Crossing with Traffic Control with Stop/Go Boards
- Fig. 10.23 : Hard Shoulder in a Multilane Highway Taken up for Works
- Fig. 10.24 : Major Works with Entry/Exit Provisions for Works Traffic
- Fig. 10.25 : Roadwork with Complicated Diversions & Contra Flow
- Fig. 10.26 : Roadwork Vehicle, Truck Attenuators & Shadow Vehicle
- Fig. 10.27 : Roadwork Near Entry Ramps with Arrow Panel Display
- Fig. 10.28 : Stage-1 of Developing Major Cross Road Junction to a Cloverleaf Interchange
- Fig. 10.29 : Stage-2 of Developing Major Cross Road Junction to a Cloverleaf Interchange

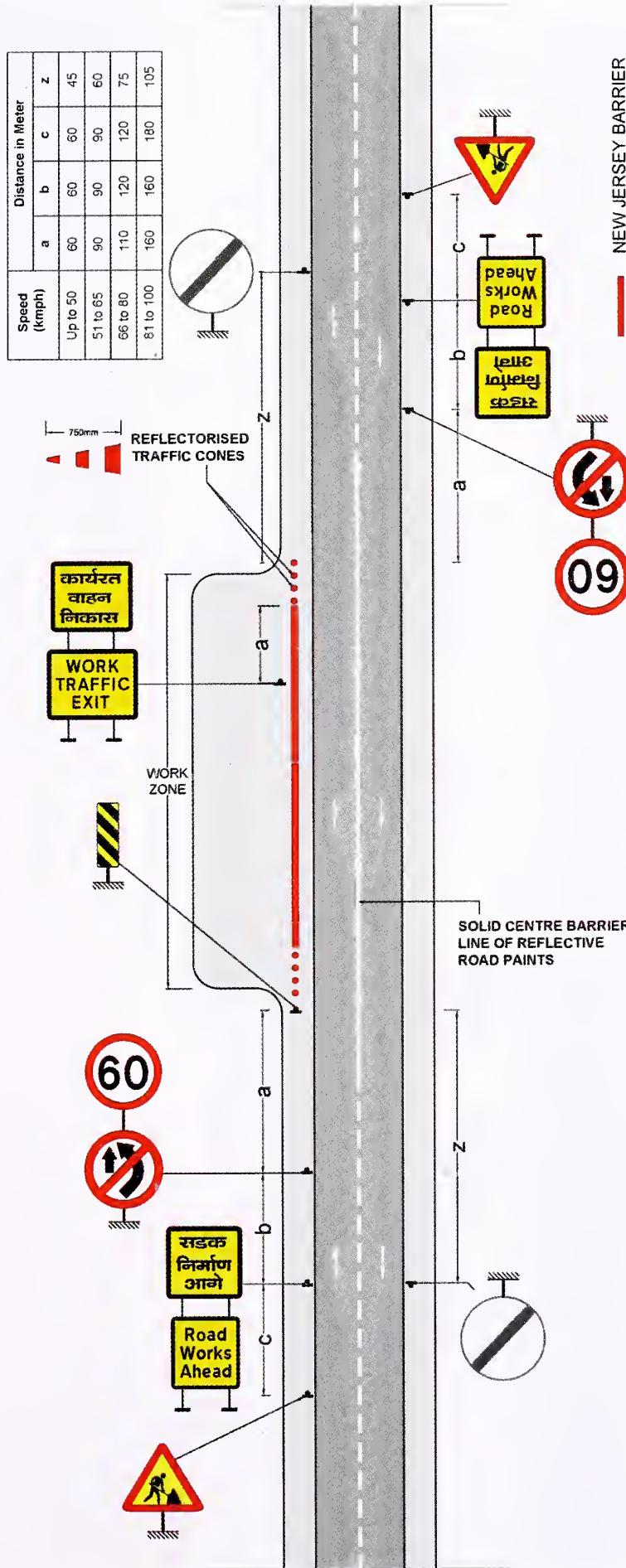


Fig. 10.1 Two Lane to Four Lane (Eccentric Widening)

APPLICATION :

The layout shown is applicable when a two lane highway is upgraded to 4-lane, with eccentric widening. In the first stage, the new carriageway would be constructed on the sides. While the new carriageway is being constructed, the traffic will continue to ply through the existing road. Layout of signs and barriers would be as shown.

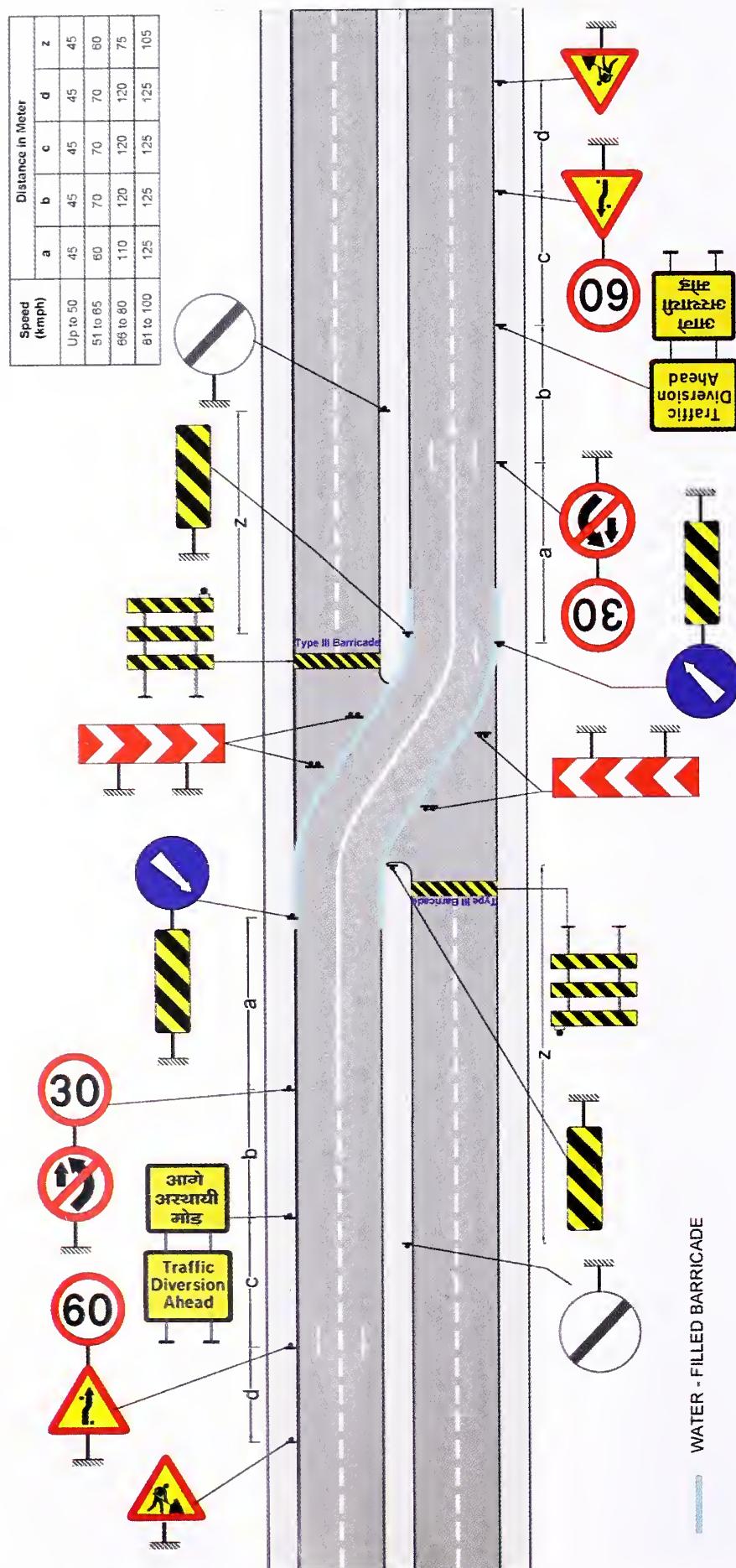


Fig. 10.2 Two Lane to Four Lane (Shifting of Traffic from One Carriageway to Other)

APPLICATION :

The layout is applicable for the second stage of eccentric widening when new carriageway has been constructed and existing carriageway is taken up for strengthening or overlay, where traffic has to be shifted from one carriageway to other. In shifting traffic from one carriageway to other, the cross over length is critical and shall be carefully provided, meeting the site requirements such that the layout is clearly visible with adequate signs and markings in a well guided way, to be visible both day and night. In the cross over length the camber also shall be properly given for safe transfer to avoid overturn due to reverse camber. It would be advisable to bring about gradual reduction in speed. Layout of signs and barriers would be as shown.

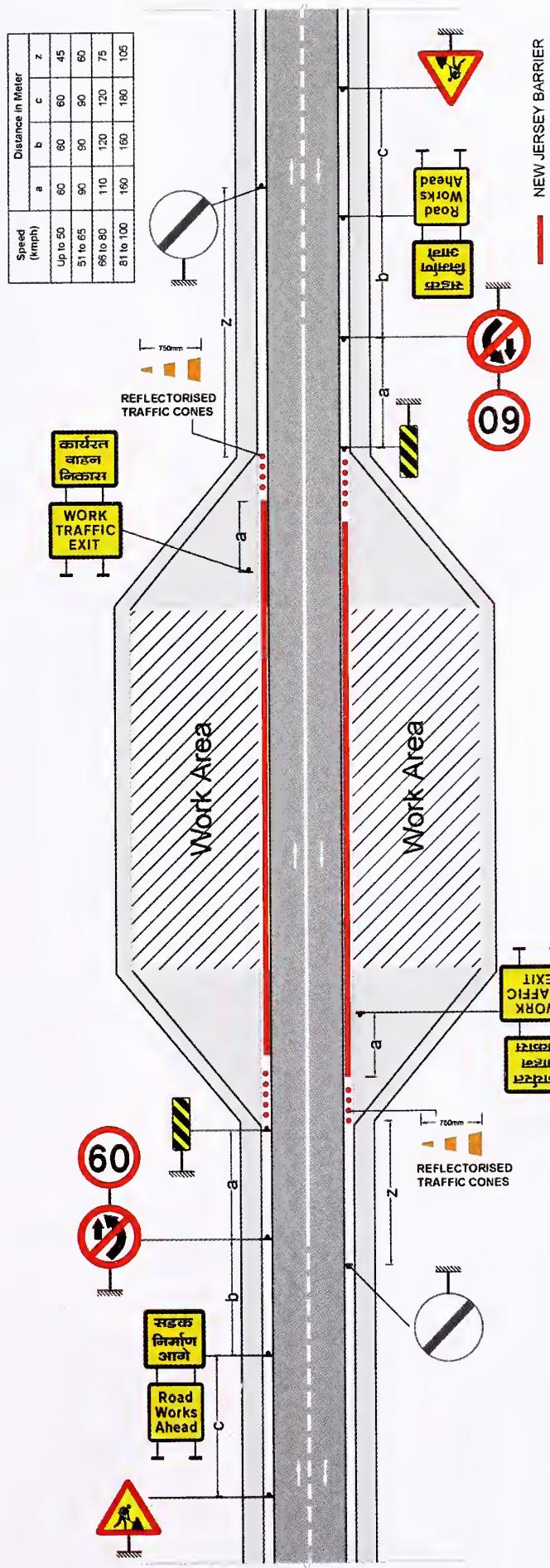


Fig. 10.3 Two Lane to Four Lane (Concentric Widening)

APPLICATION

The layout shown is applicable for concentric widening of a two lane highway 4-lane highway. In the first stage, construction of service road or diversion road would be taken up on the sides and traffic would continue to move on main highway on both directions.

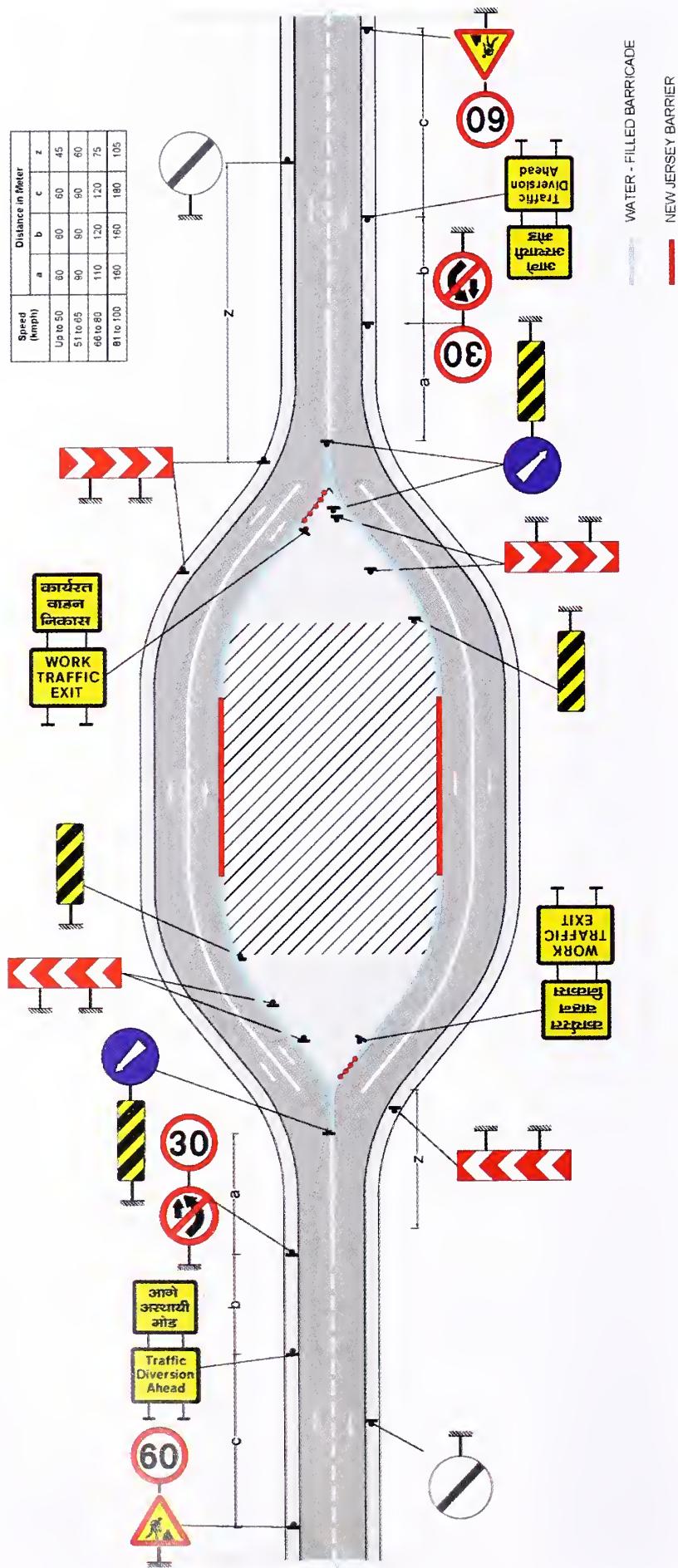


Fig. 10.4 Two Lane to 4-Lane/6-Lane (Concentric Widening)

APPLICATION :

The layout is applicable for the second stage of upgrading 2-lane highway to 4-lane. The traffic would move on newly constructed service/diversion roads in each direction and widening work on both carriageways including median is done in the central cordoned portion. Necessary warning signs will be given to inform of roadwork being undertaken. Layout for signs and barriers would be as shown.

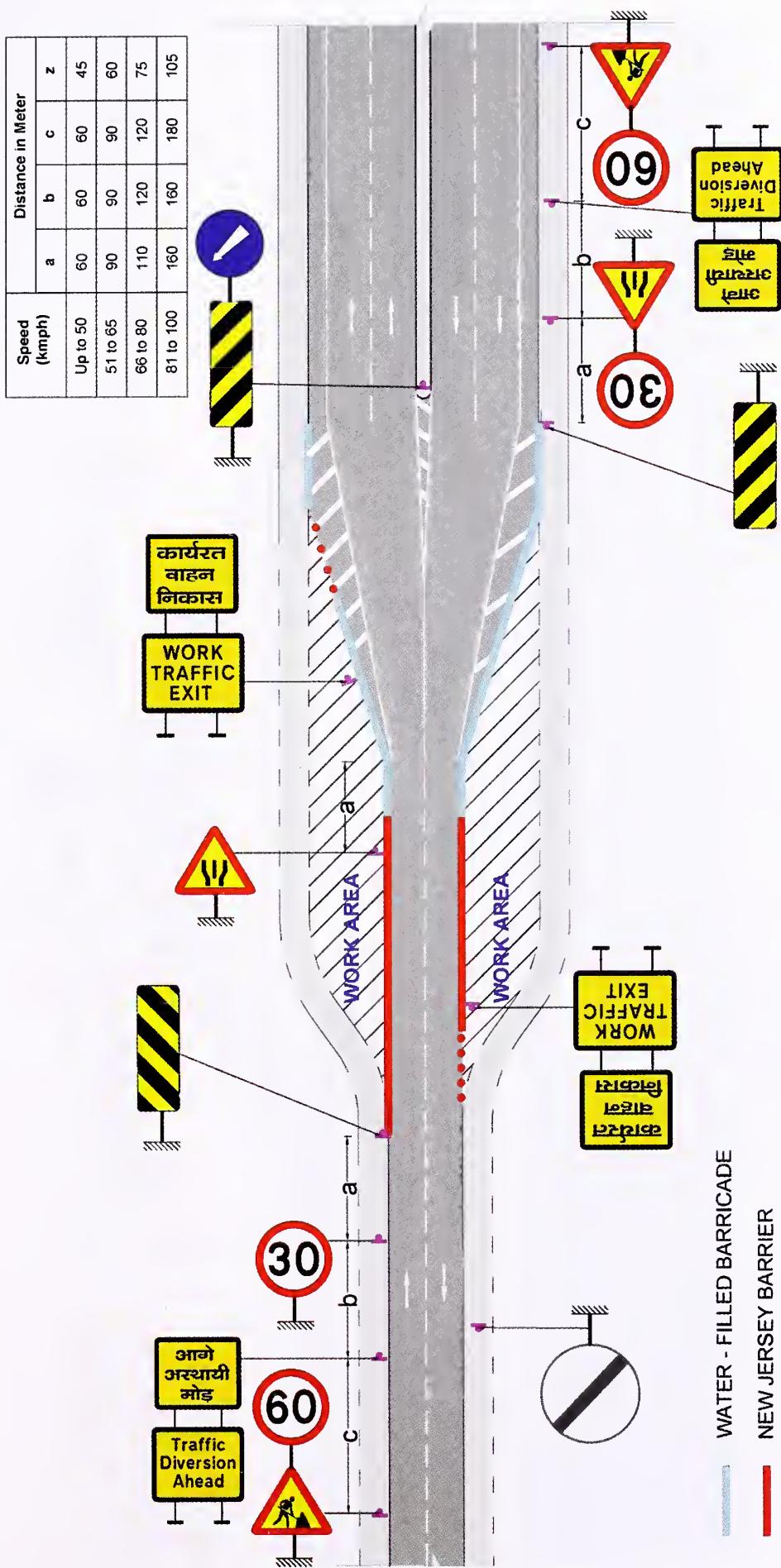


Fig. 10.5 2-Lane to 4-Lane – Concentric

APPLICATION :

The layout is the third stage of concentric widening for 2-lane to 4-lane showing the shifting/forward movement of work zone to the next stretch for progress of construction activities.

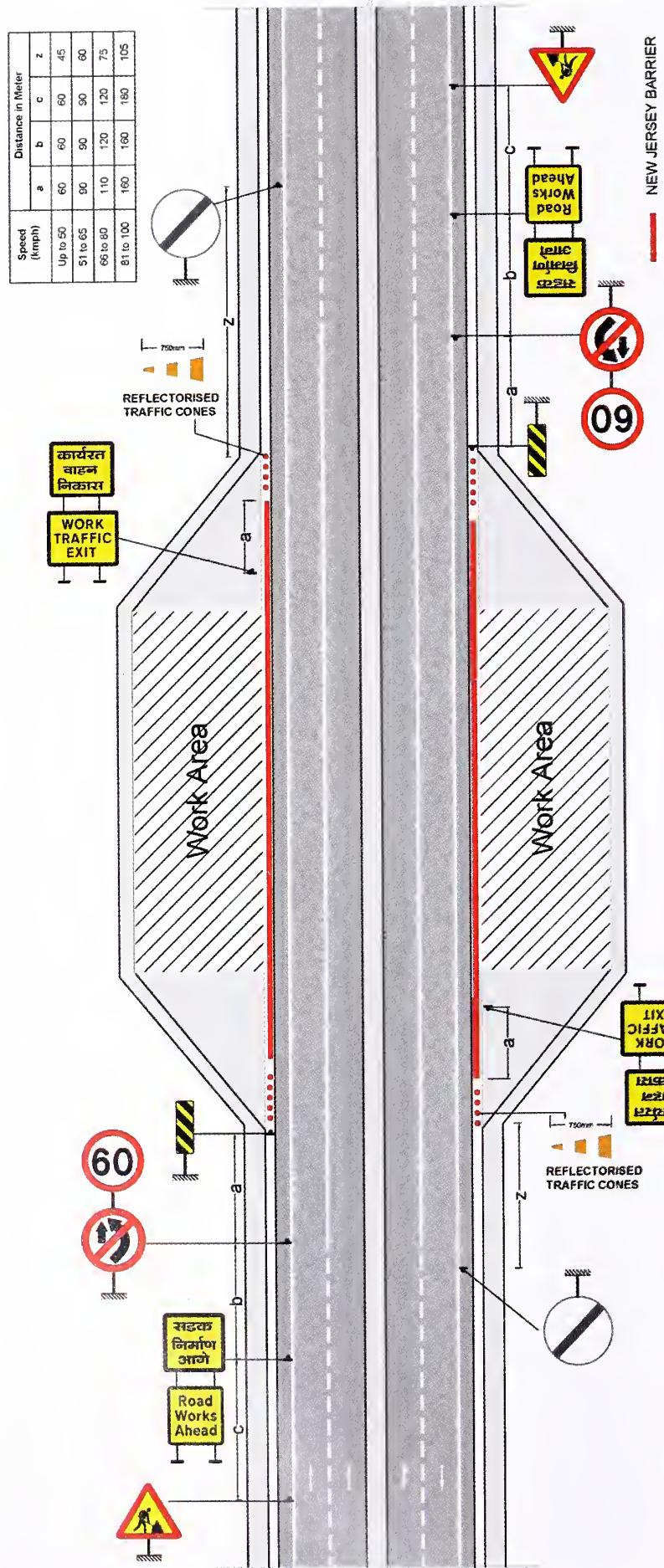


Fig. 10.6 Four Lane to Six-Lane – Concentric Widening

APPLICATION :

The layout is applicable in cases of concentric widening from 4-lanes to 6-lanes. In the first stage service roads will be constructed on both sides, while traffic continues to ply through the existing 4-lane highway. Warning signs and barriers will be installed as shown to inform of road works being undertaken.

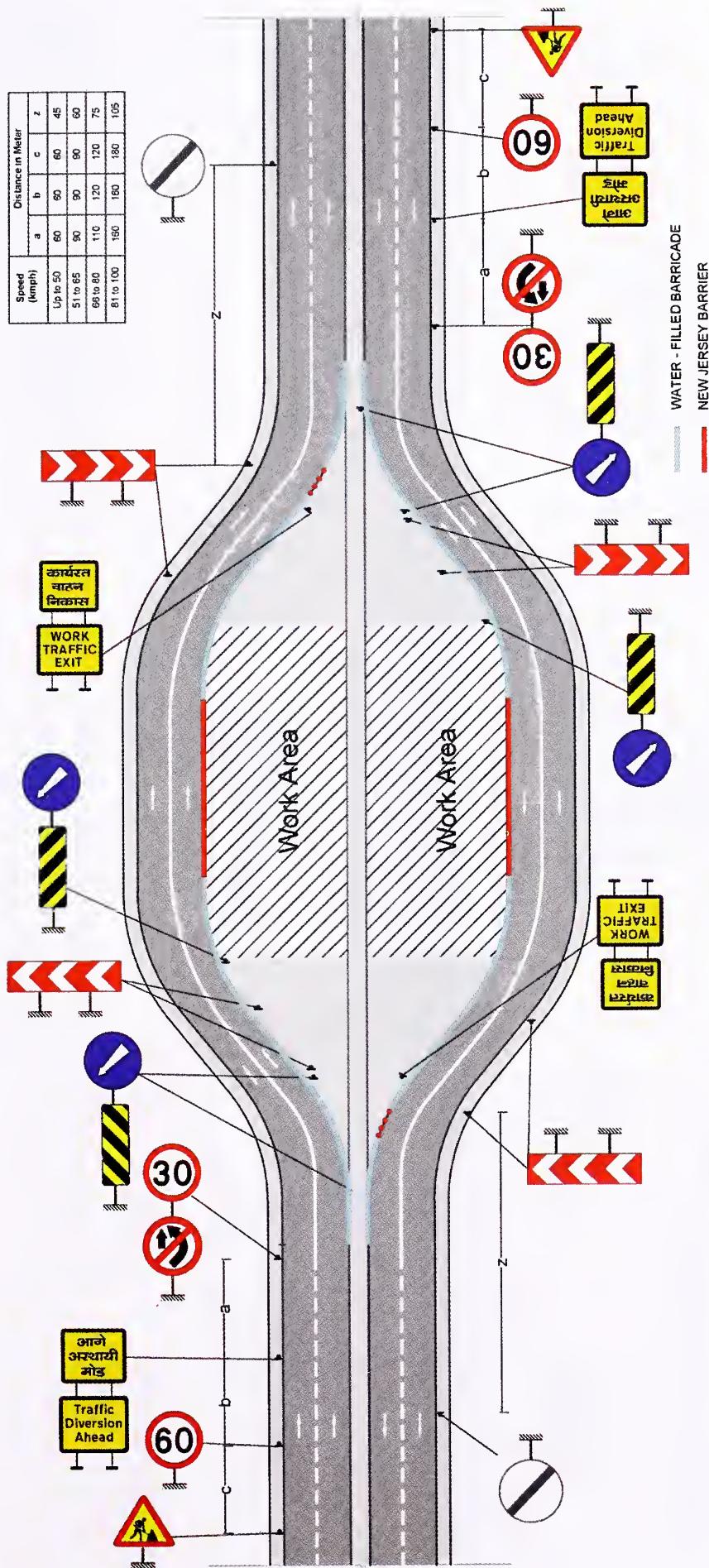


Fig. 10.7 Four Lane to Six Lane - Concentric Widening

APPLICATION :

In the second stage, the traffic will be shifted to service road so constructed. The construction of additional one lane on each carriageway along with median would be taken up in as shown in the layout. The transition from existing main carriageway to service road shall be carefully planned as per site condition for safe negotiation of traffic. Layout of signs and barriers would be as shown. Further progression of work would be similar as shown in Fig. 10.5.

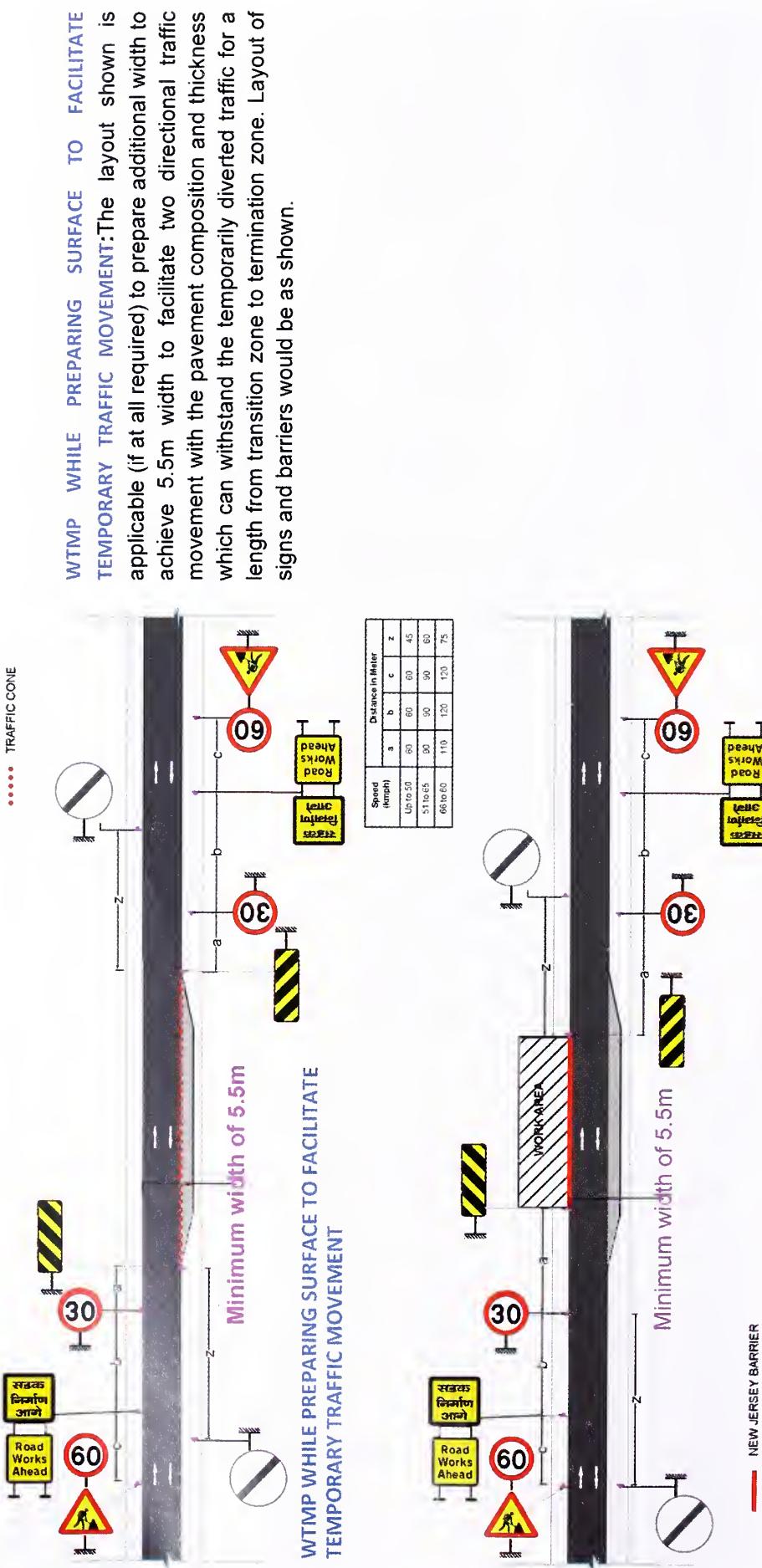


Fig. 10.8 Stage-1 Upgrading of Single/Intermediate Lane Road to 2-Lane with Shoulders

APPLICATION :

The layout shown is applicable when a single lane or intermediate or two lane carriageway is upgraded to standard two lanes with paved or earthen shoulder. In this stage, the work will be taken up adjacent to existing traffic movement with traffic control measures. Layout of signs and barriers would be as shown.

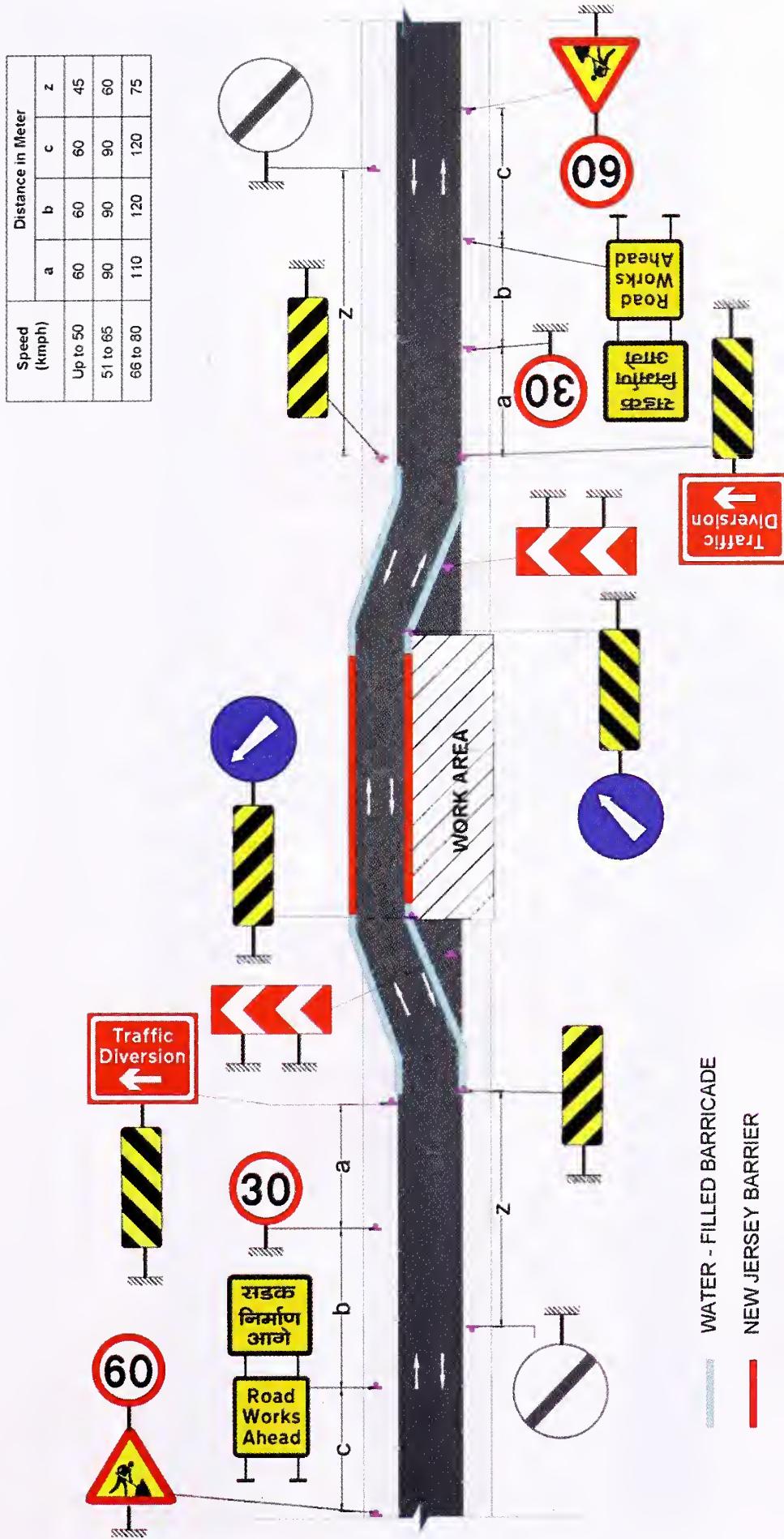


Fig. 10.9 Stage-2 Upgrading of Single/Intermediate Lane Road into 2-Lane with Shoulders

APPLICATION :

In the subsequent stage, the traffic will be diverted to the portion of carriageway and shoulder developed during the first stage. Layout of signs and barriers would be as shown.

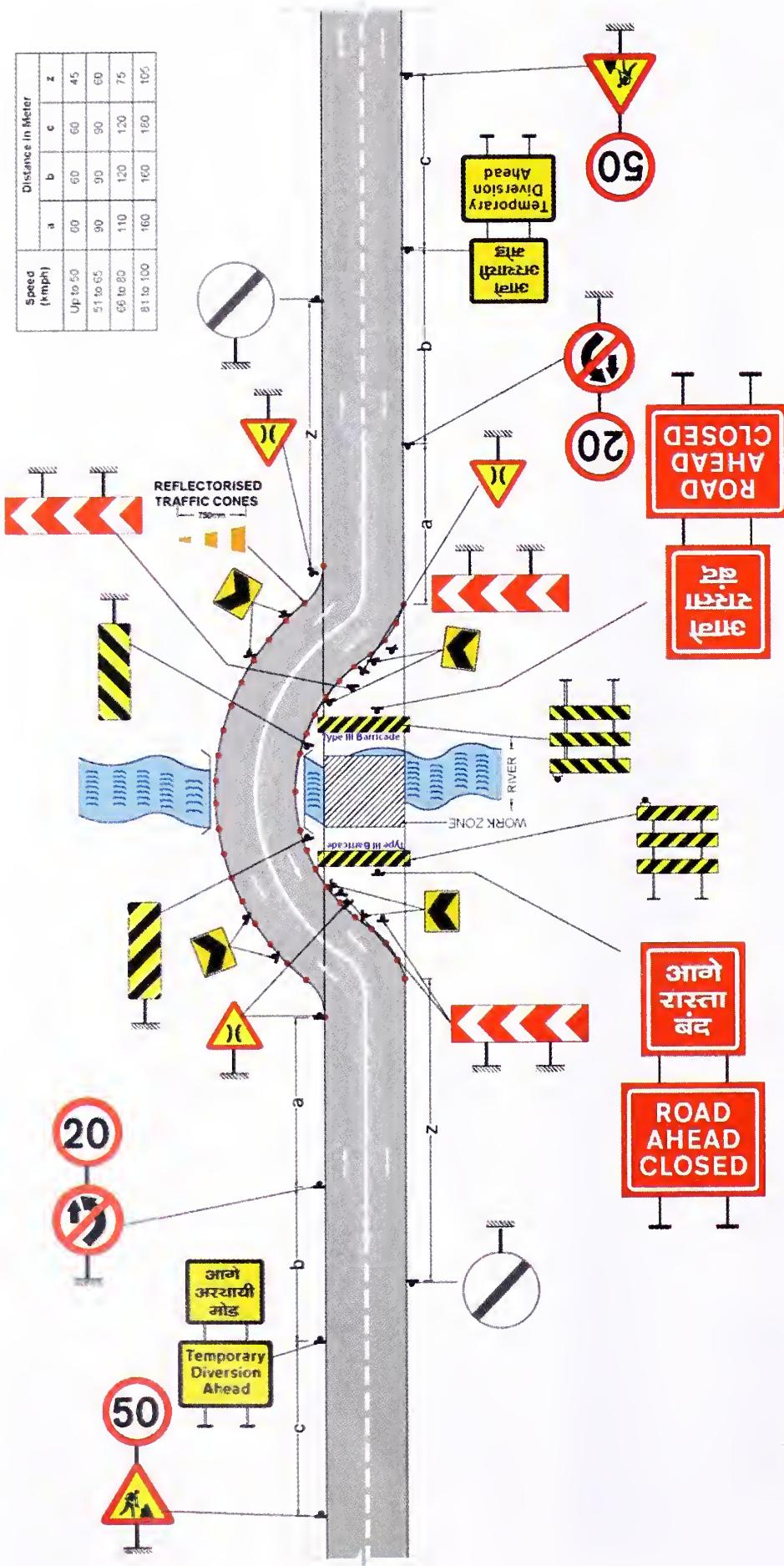


Fig. 10.10 Temporary Diversion for Reconstruction of CD Works

APPLICATION :

The layout shown is applicable when a Cross Drainage structure has to be constructed and where a temporary diversion will need to be constructed for maintaining the traffic flow. The diversion in most cases would be on embankment; therefore delineation is essential for both day and night time.

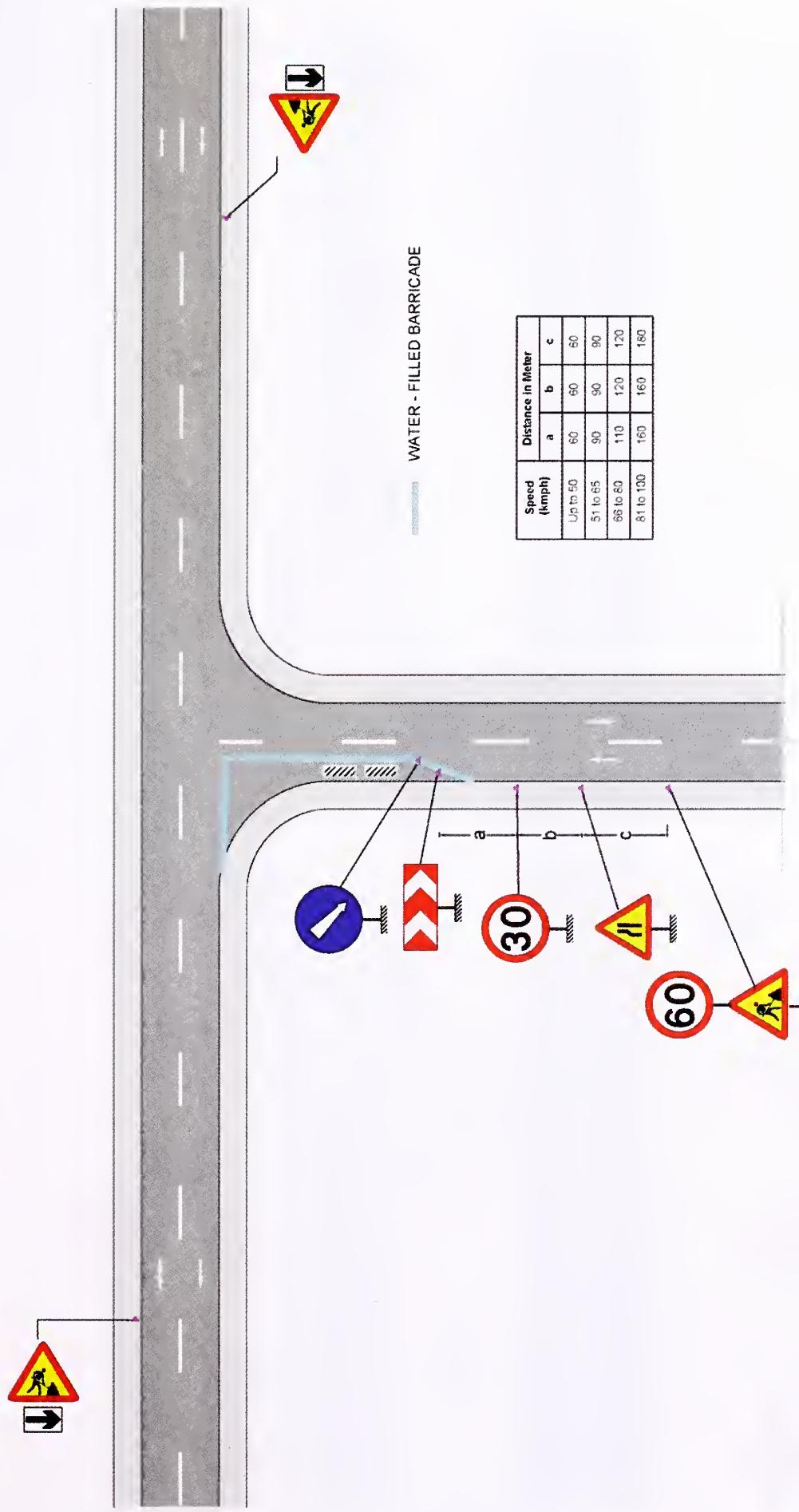


Fig. 10.11 Roadwork in Junction Area

APPLICATION :

The layout shown is applicable some work at the junction area involving deflection of traffic.

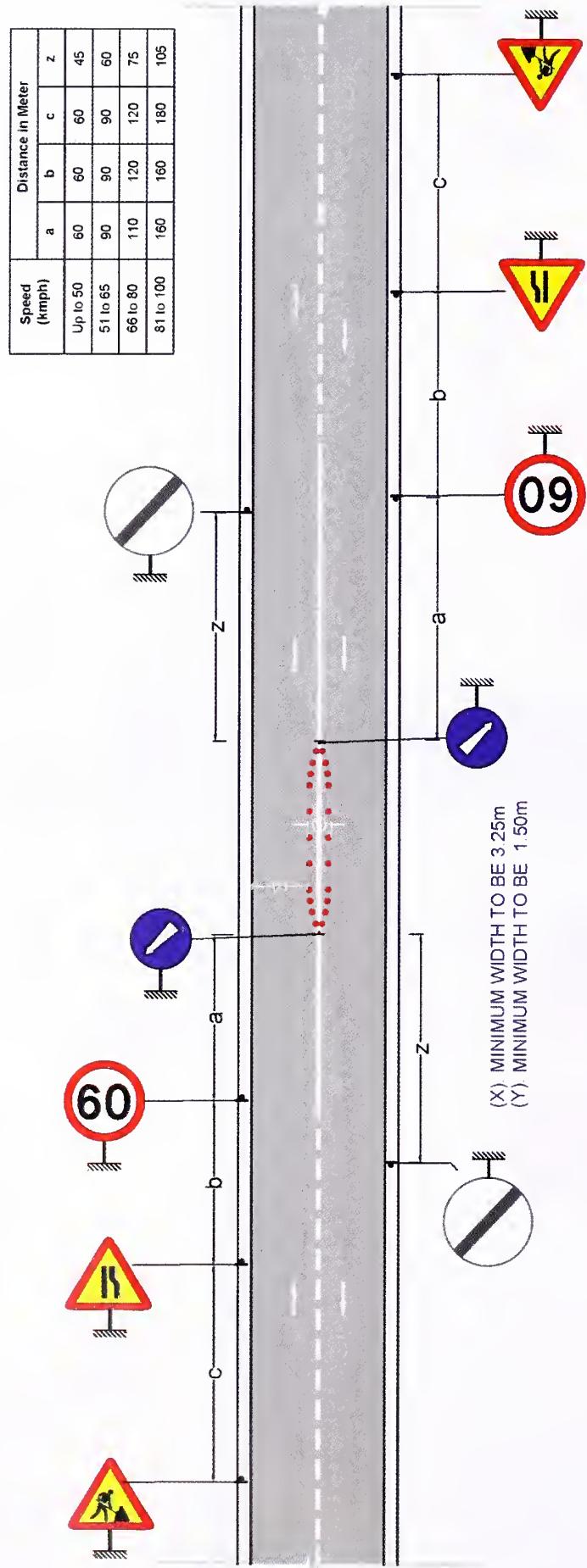


Fig. 10.12 Work at Center of Carriageway

APPLICATION :

The layout shown is applicable for short term maintenance activities at the center of a carriageway. Generally traffic cones are used that it can be placed and removed easily.

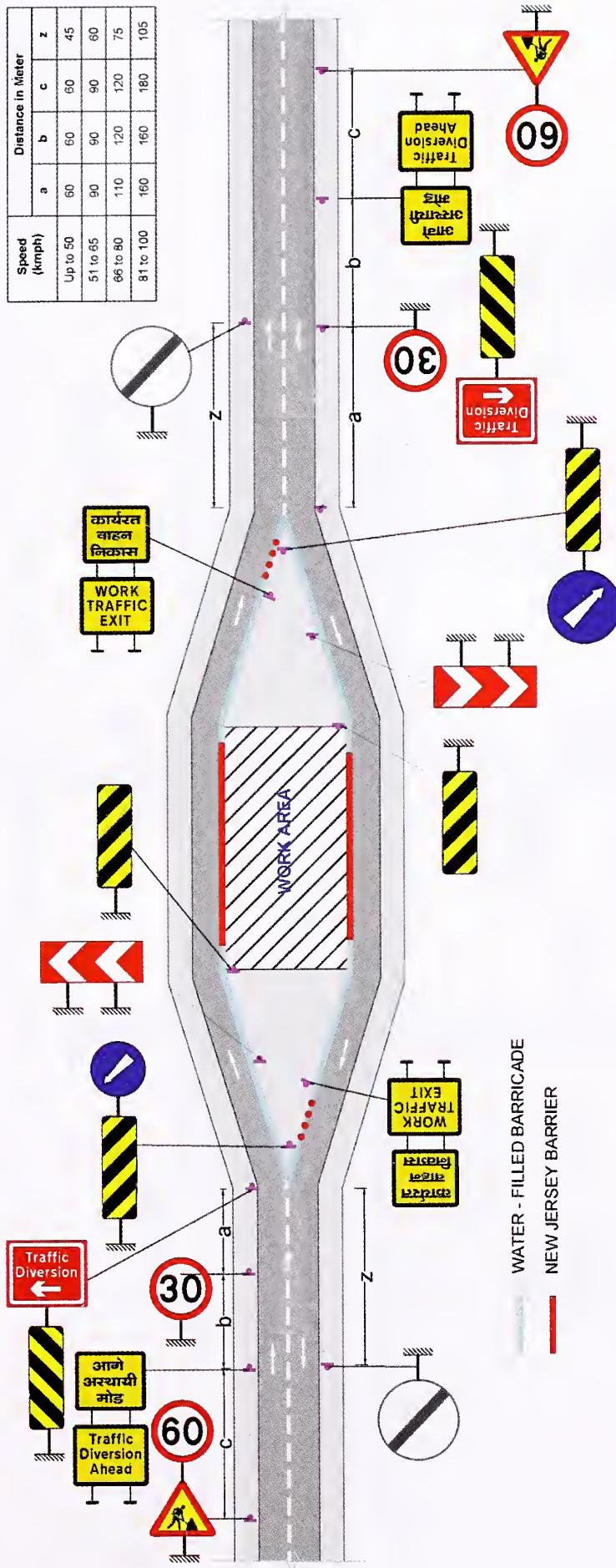


Fig. 10.13 One Direction for Major Work at the Centre of Road

APPLICATION :

This situation may arise for major works in roads in urban area. The first stage, diversion road would be constructed for both direction one way traffic movement as shown in layout for safe movement of through traffic and actual work will be undertaken subsequently in the central portion.

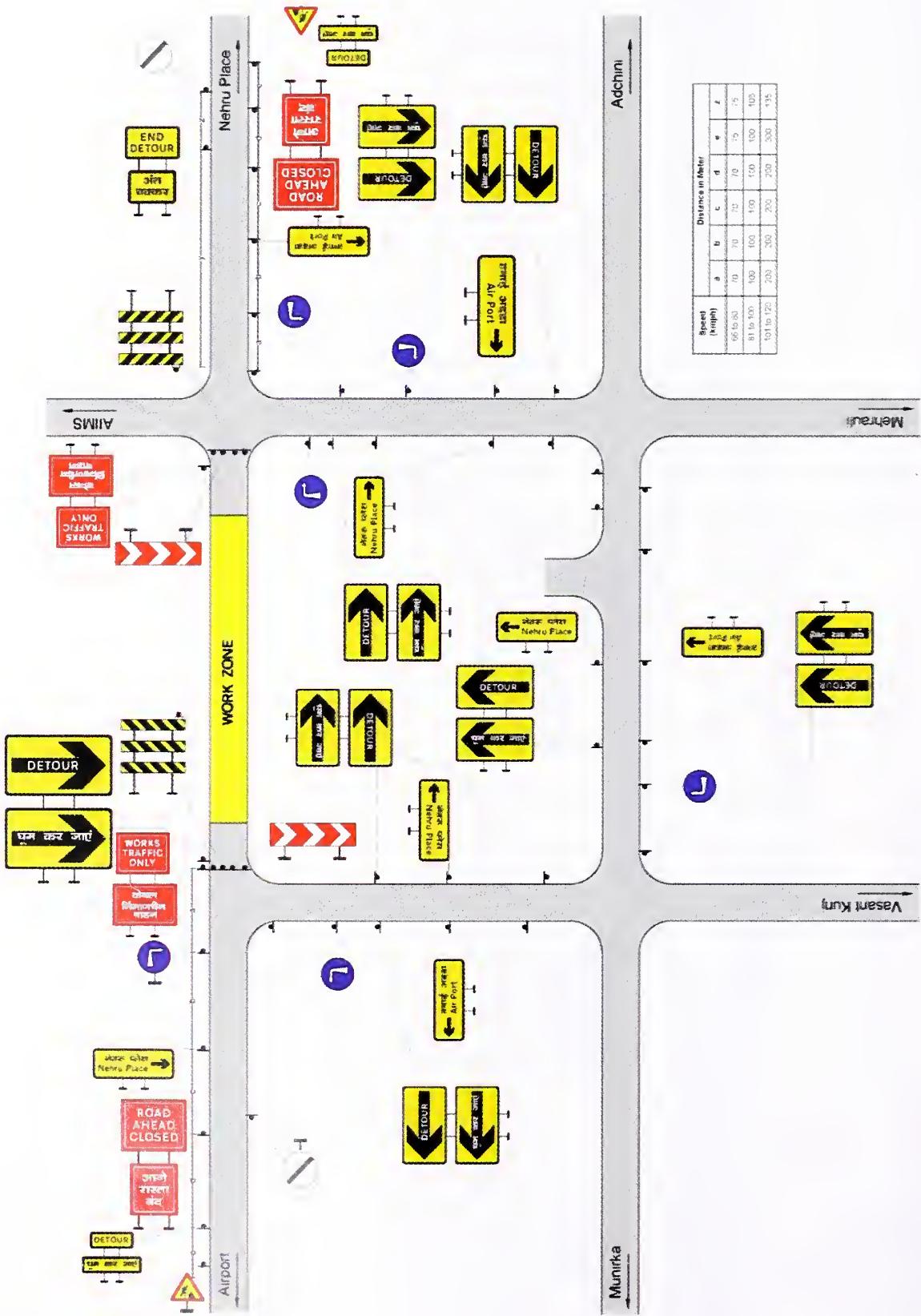


Fig. 10.14 Road Work with Detour/Bypassing

APPLICATION :

The layout shown is applicable when a mid-block of a main route is taken up for total reconstruction necessitating road closer and traffic has to detour through other adjacent roads of the network.

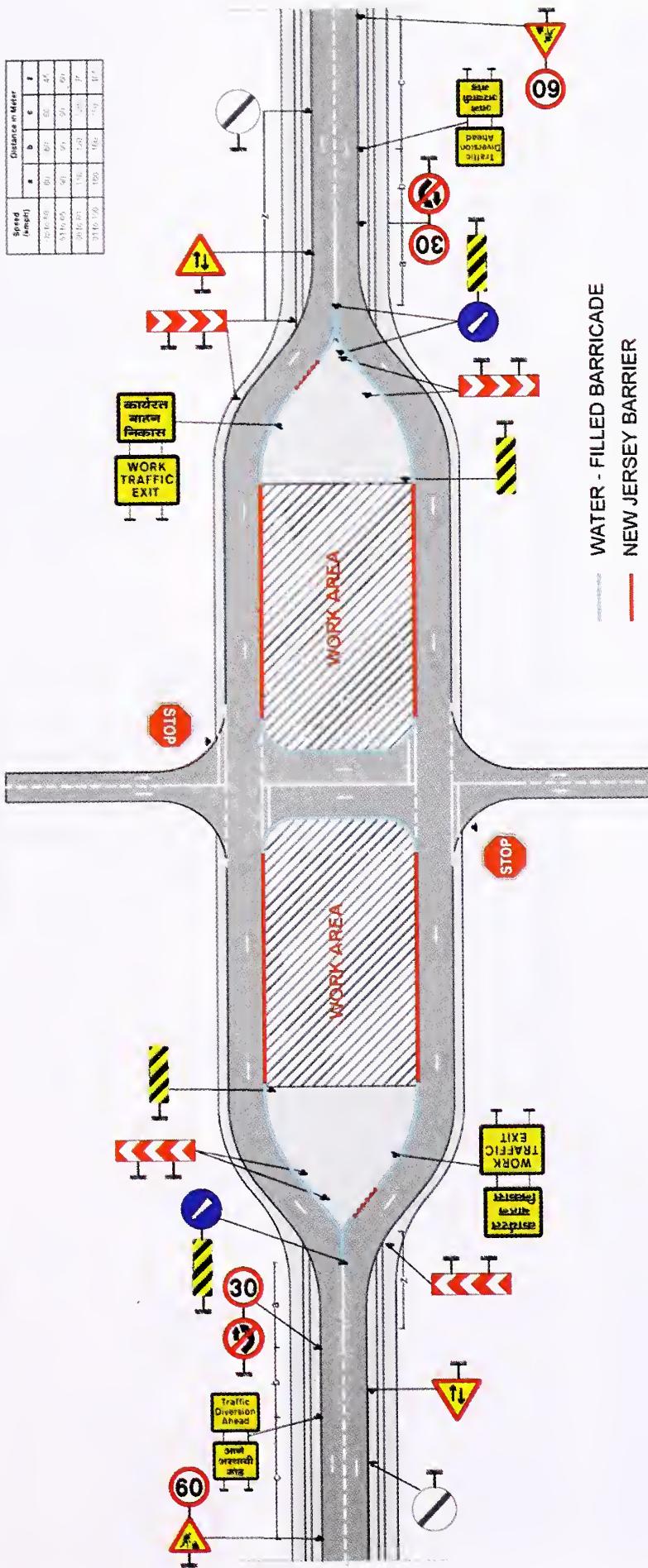


Fig. 10.15 Stage-1 of Flyover/VUP Construction

APPLICATION :

The layout shows the Stage-1 in flyover/VUP construction. In the first stage, the traffic will be diverted to a service road or temporary road. The turning movements would continue at the existing intersection and construction of piers/embankment/RE wall would be taken up in the cordoned portion. Carefully planned pedestrian markings on the roads and protected safe passage for crossing of pedestrians shall be provided through work area.

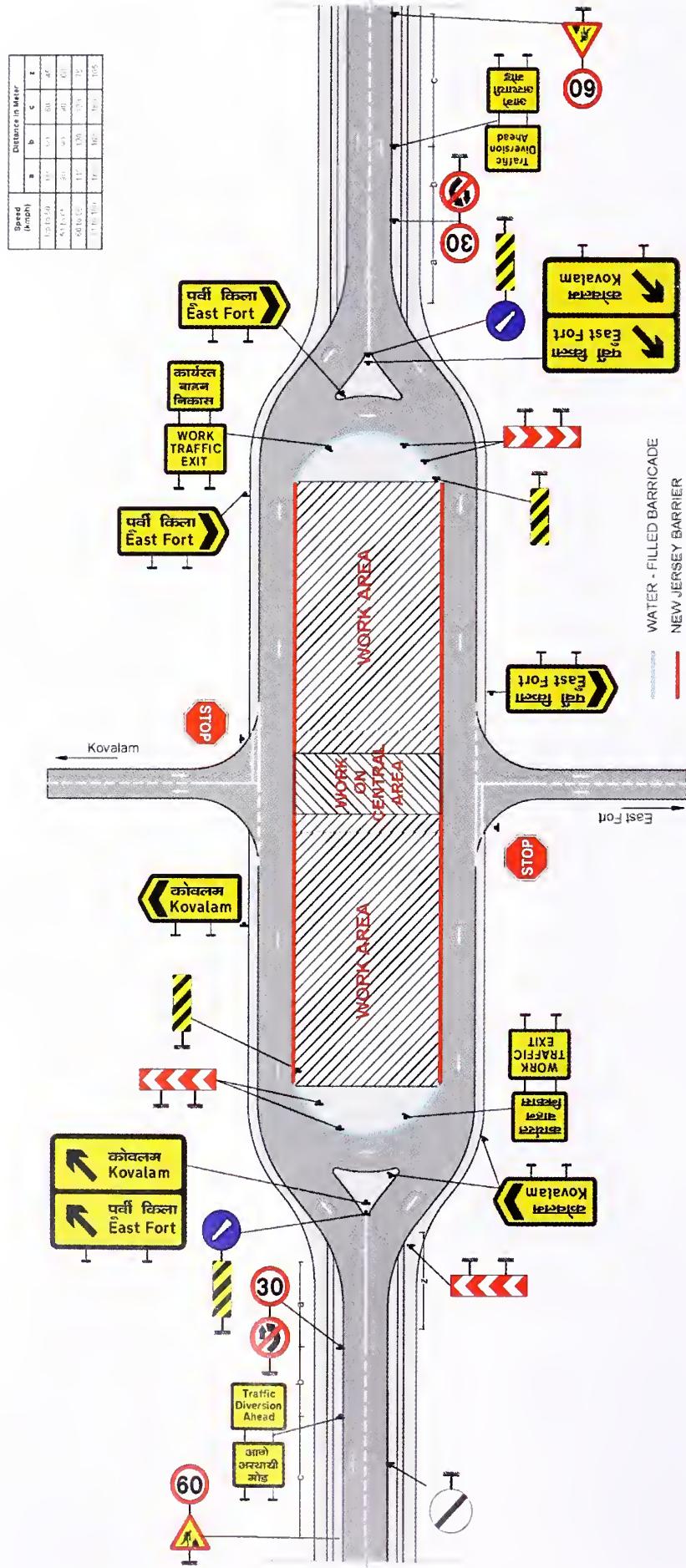


Fig. 10.16 Stage-2 of Flyover/VUP Construction

APPLICATION :

The layout shows Stage-2 of flyover/VUP construction. In the second stage, the central portion will be taken up and junction will be blocked for direct cross road movement. During this short period of time, cross road movement will be accommodated like a circulatory movement using U-turn, whereas the through traffic will continue to ply through service road/temporary road. Direction signs would be carefully planned and installed. Carefully planned pedestrian markings on the roads and protected safe passage for crossing of vehicles shall be provided through work area.

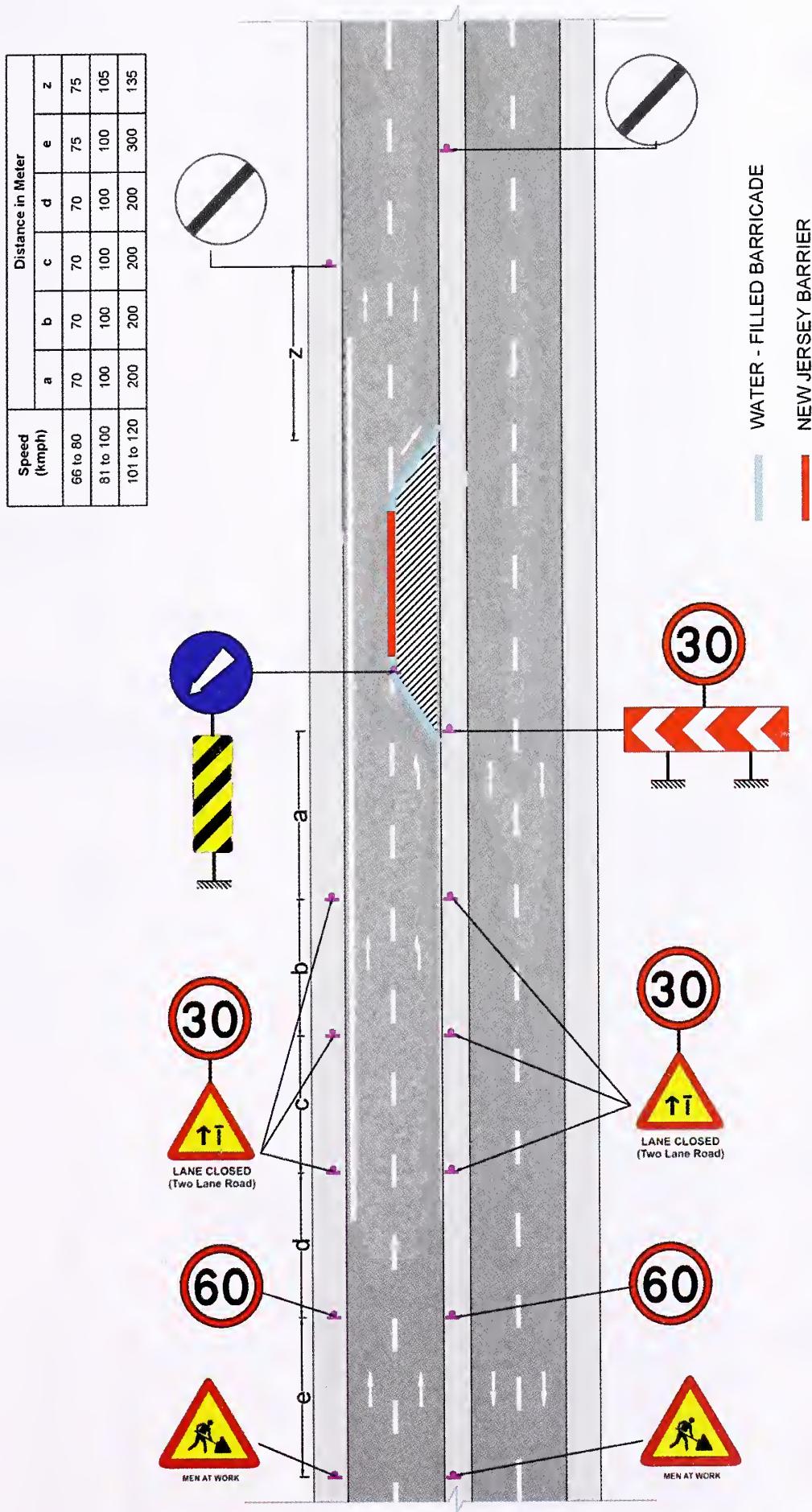


Fig. 10.17 Fast Lane Taken Up for Work

APPLICATION :

The layout shown is applicable when the fast extreme right lane in a multi-lane highway is taken up for work.

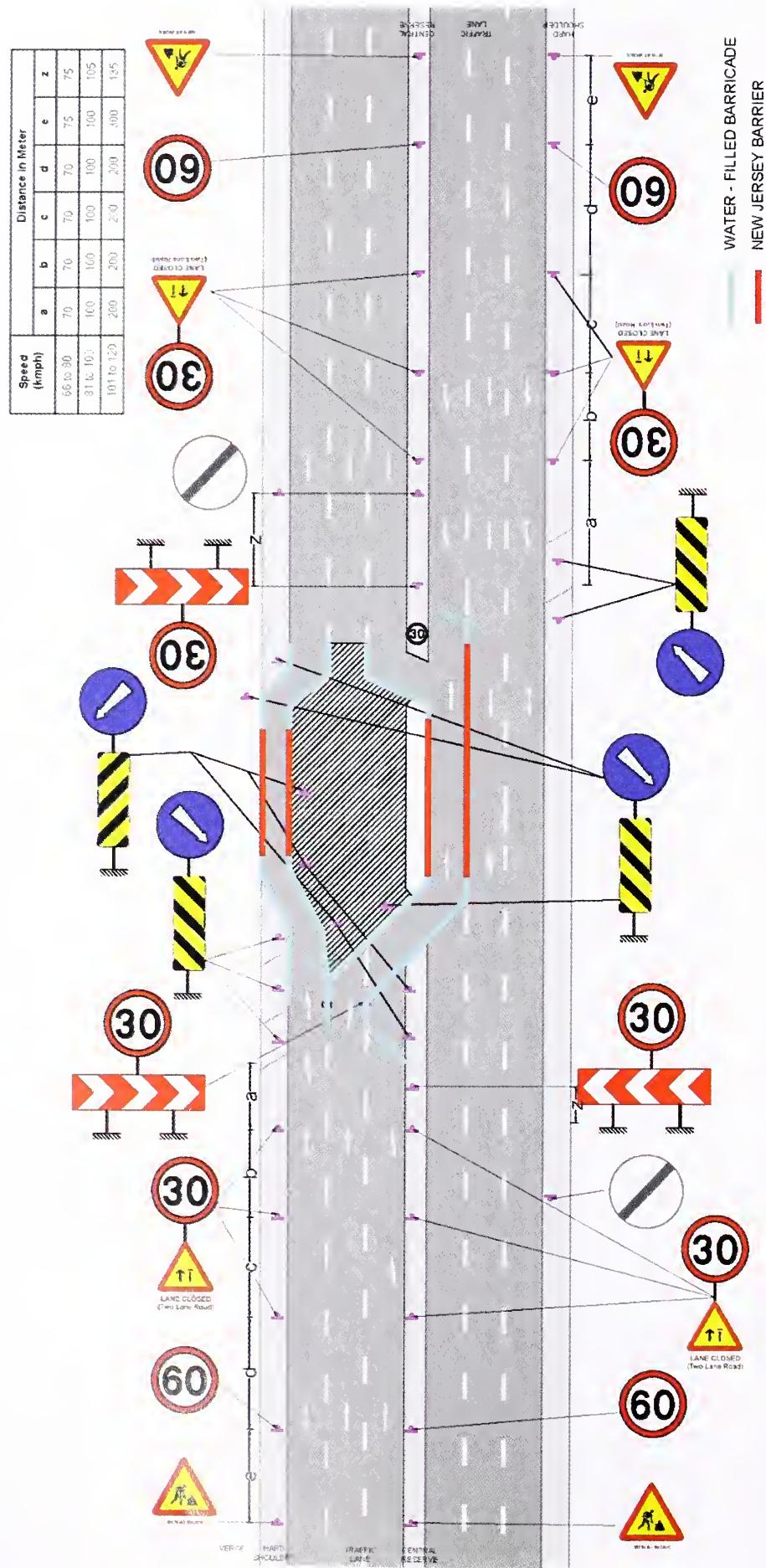


Fig. 10.18 Roadwork Affecting Both Carriageways of Expressway

APPLICATION :

The layout shown is applicable in an access controlled expressway as the ongoing work affects both carriageways, involving delicate diversions.

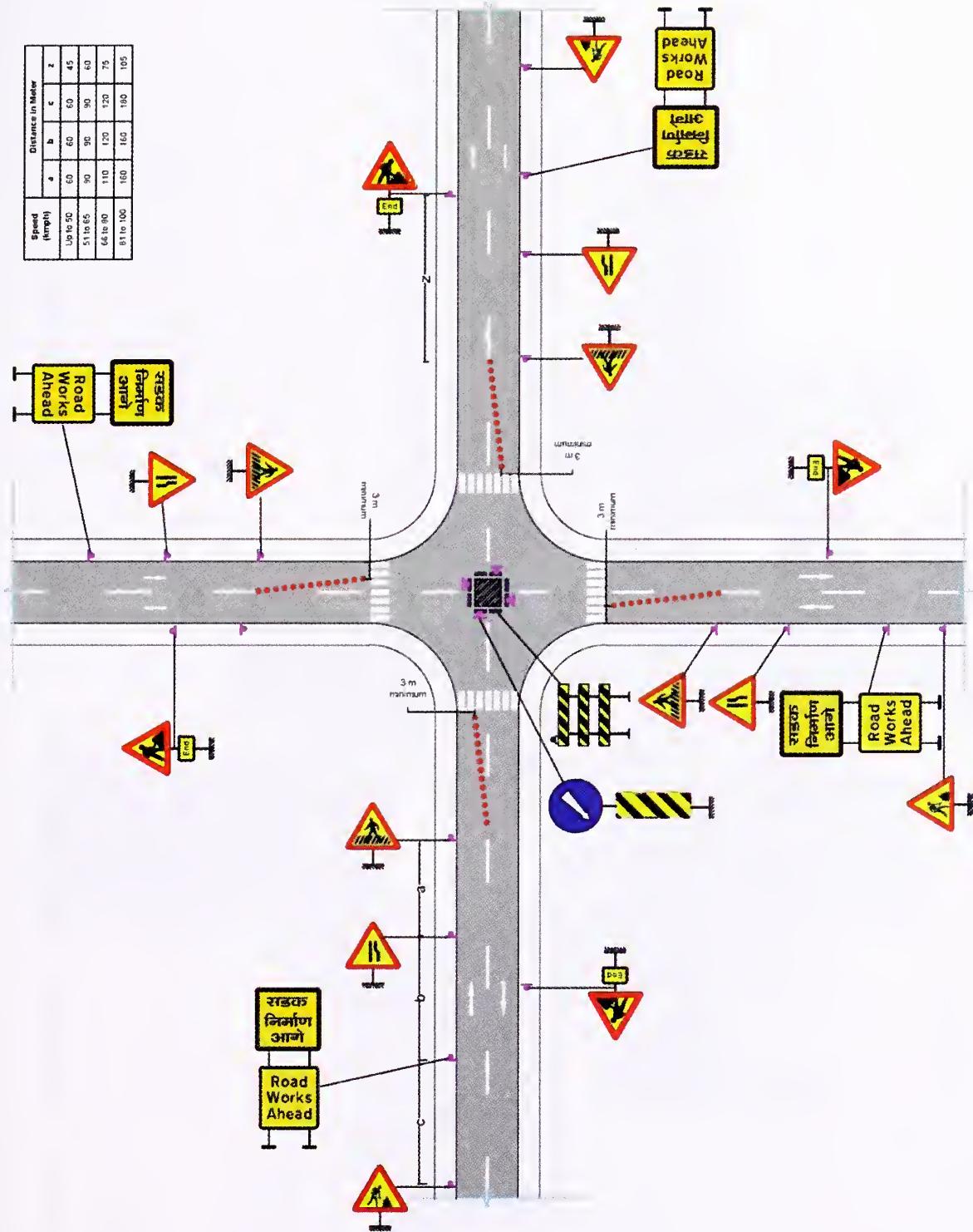


Fig. 10.19 Road Work at the Centre of a Junction

APPLICATION :

The layout shown is applicable when works are to be carried out at the centre of junction

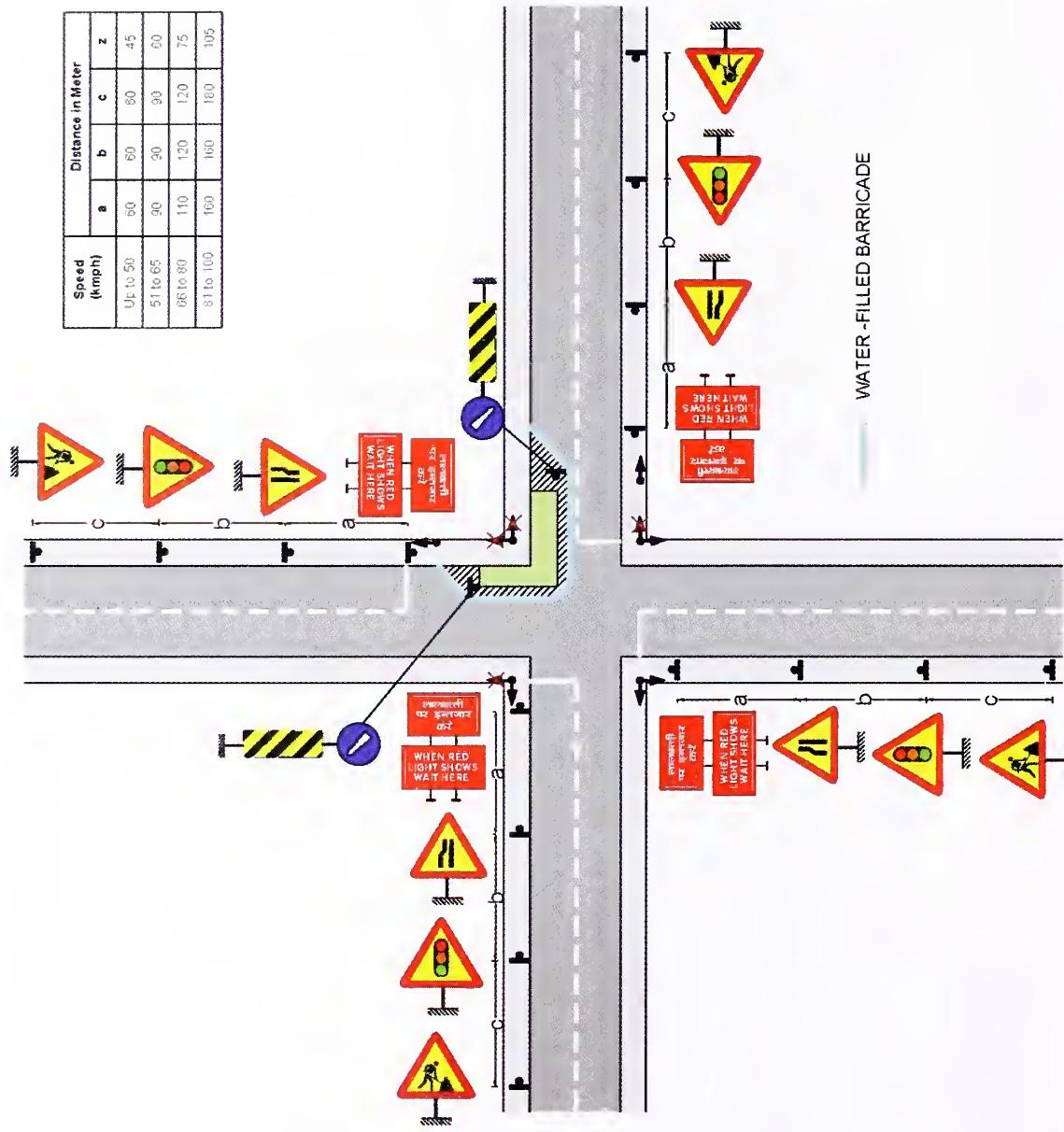


Fig. 10.20 Road Work at the Corner of a Junction with Temporary Signal Control

APPLICATION :

The layout shown is applicable when some works to be carried out at the corner with temporary signal control arrangement.

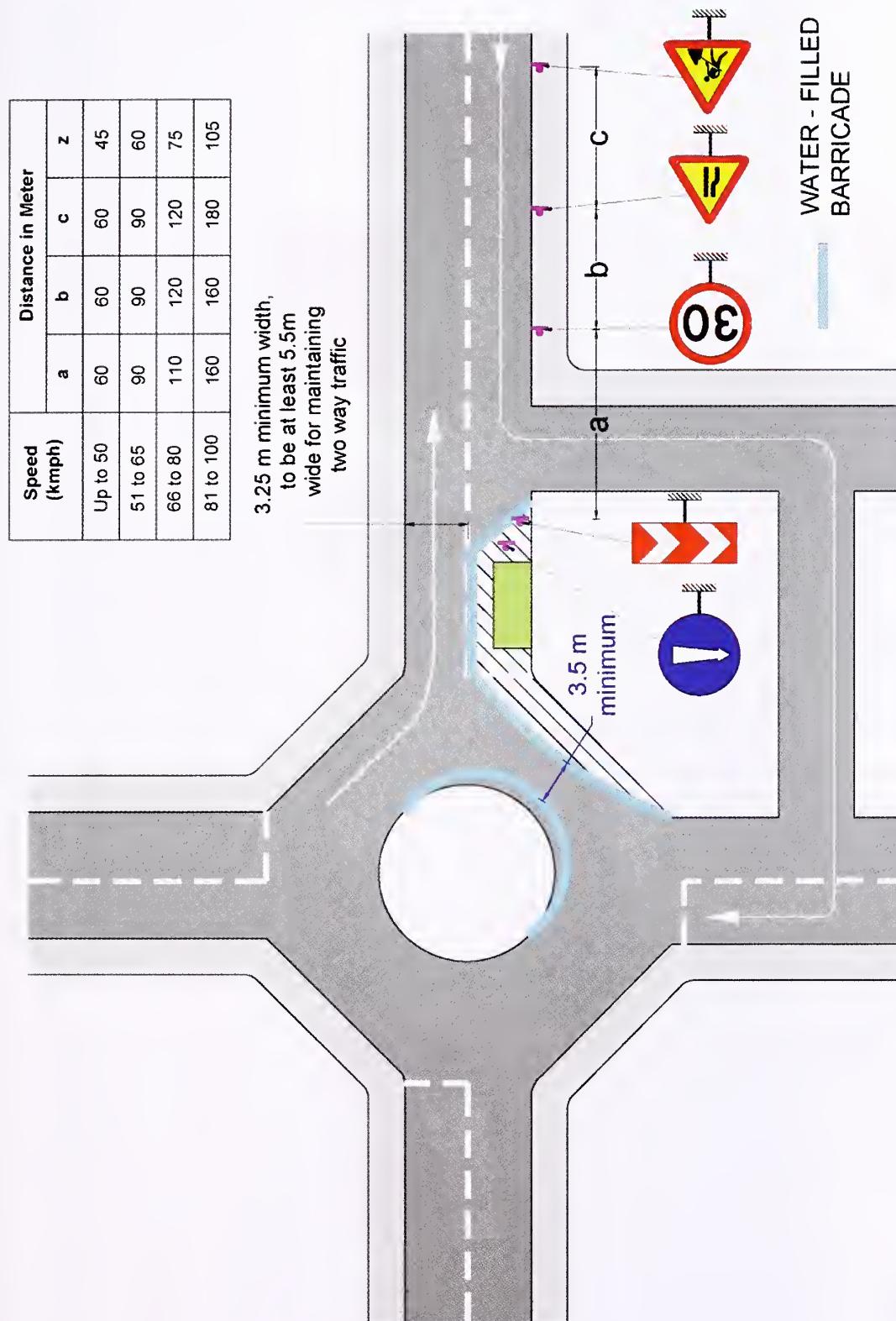


Fig. 10.21 Road Work at Roundabout with Constricted Circulatory Carriageway

APPLICATION :

The layout shown is applicable where there are activities at corner of the roundabout and the circulatory carriageway can hardly allow one lane movement only due to repair work at central island, where traffic in one approach will be redirected through an adjacent street.

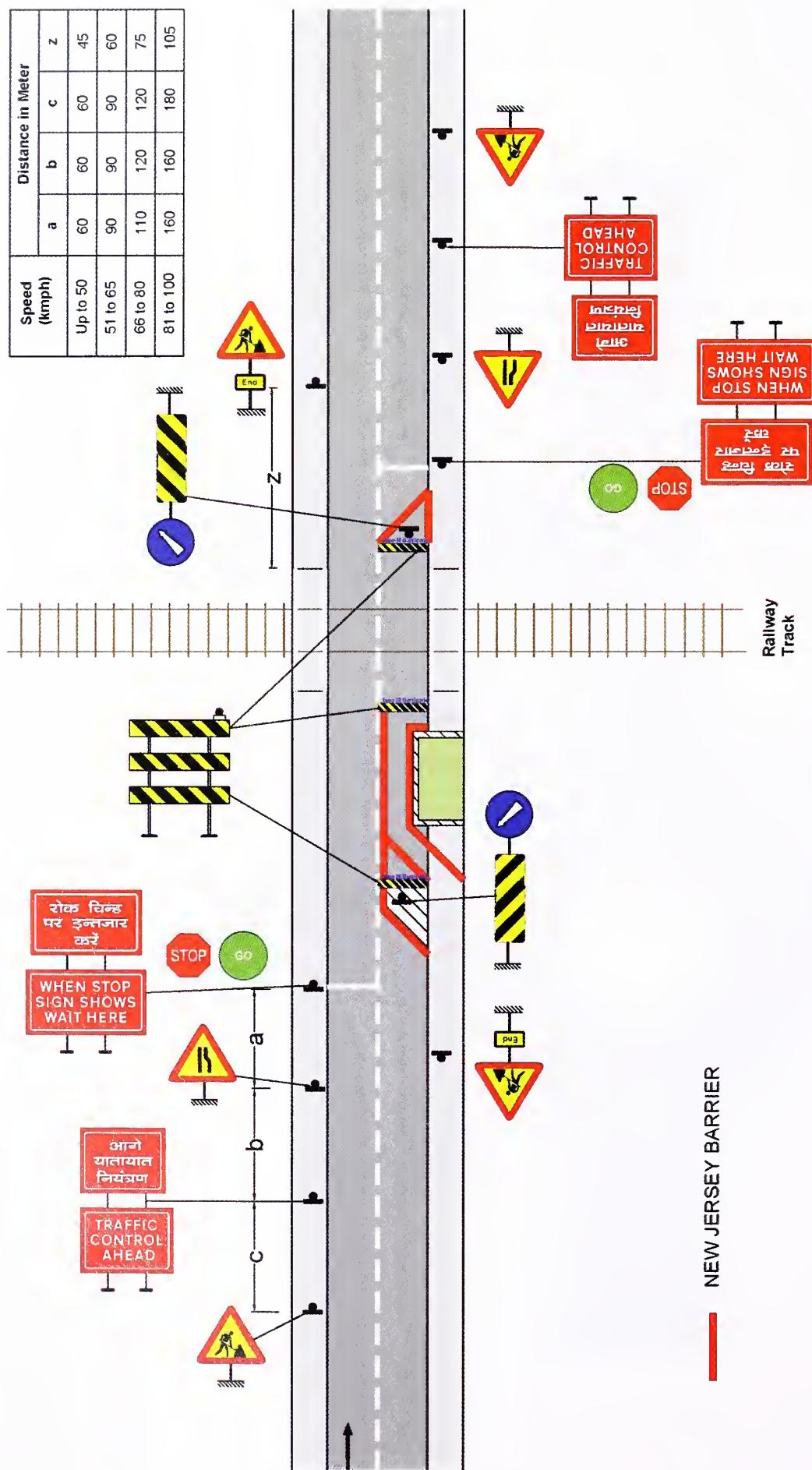


Fig. 10.22 Road Works at Level Crossing with Traffic Control with Stop/Go Boards

APPLICATION :

The layout shown is applicable for road works at level crossing with manual traffic control with Stop/Go boards. Layout of signs and barriers would be as shown.

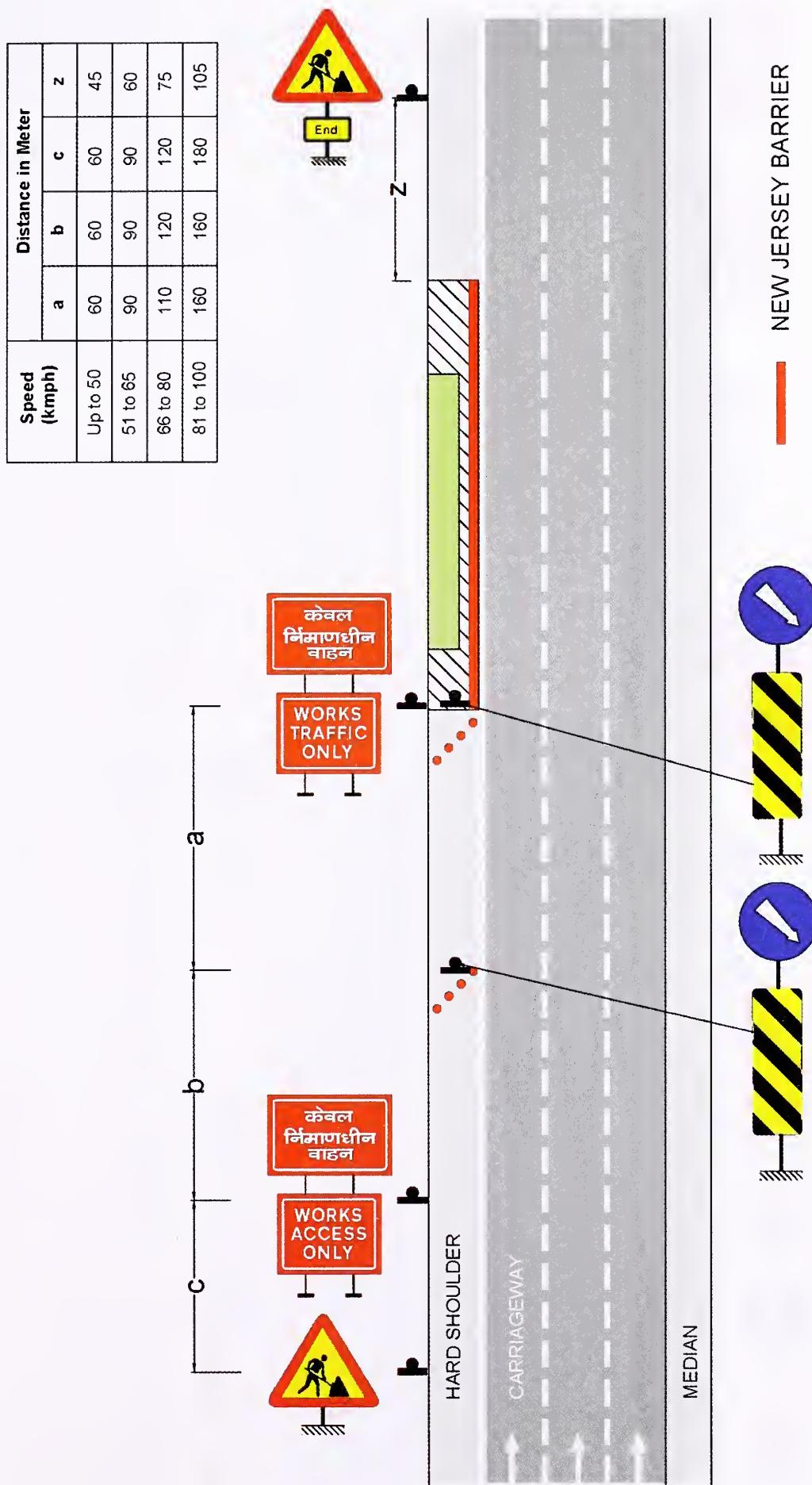


Fig. 10.23 Hard Shoulder in a Multilane Highway Taken up for Works

APPLICATION :

The layout shown is applicable when the hard shoulder in a multi-lane is taken up for work, where the trafficable carriageway is no way affected or encroached. Layout of signs and barriers would be as shown.

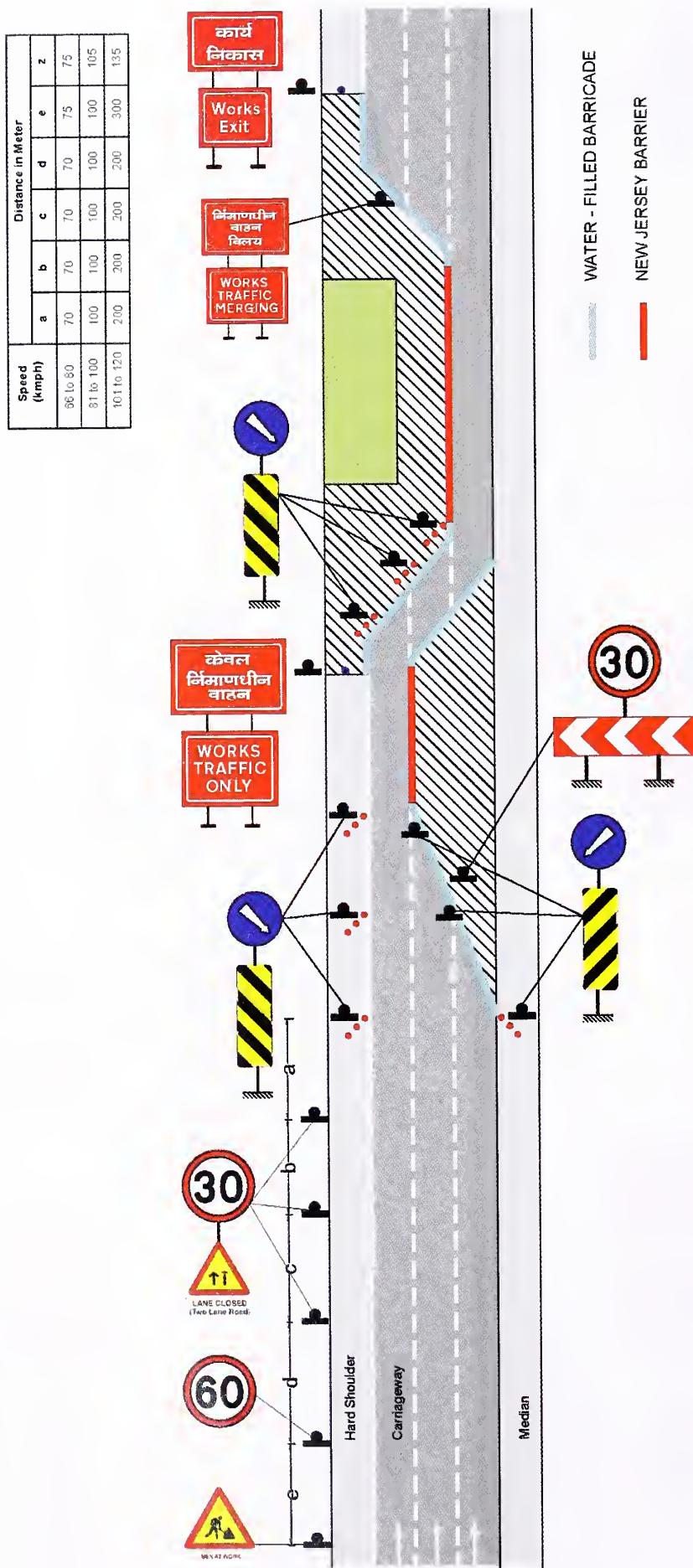


Fig. 10.24 Major Works with Entry/Exit Provisions for Works Traffic

APPLICATION :

The layout shown is applicable major road situations where two lanes out of three lanes have been blocked for works activities, involving delicate diversion, and also showing entry/exit provisions for Work Traffic. Layout of signs and barriers would be as shown.

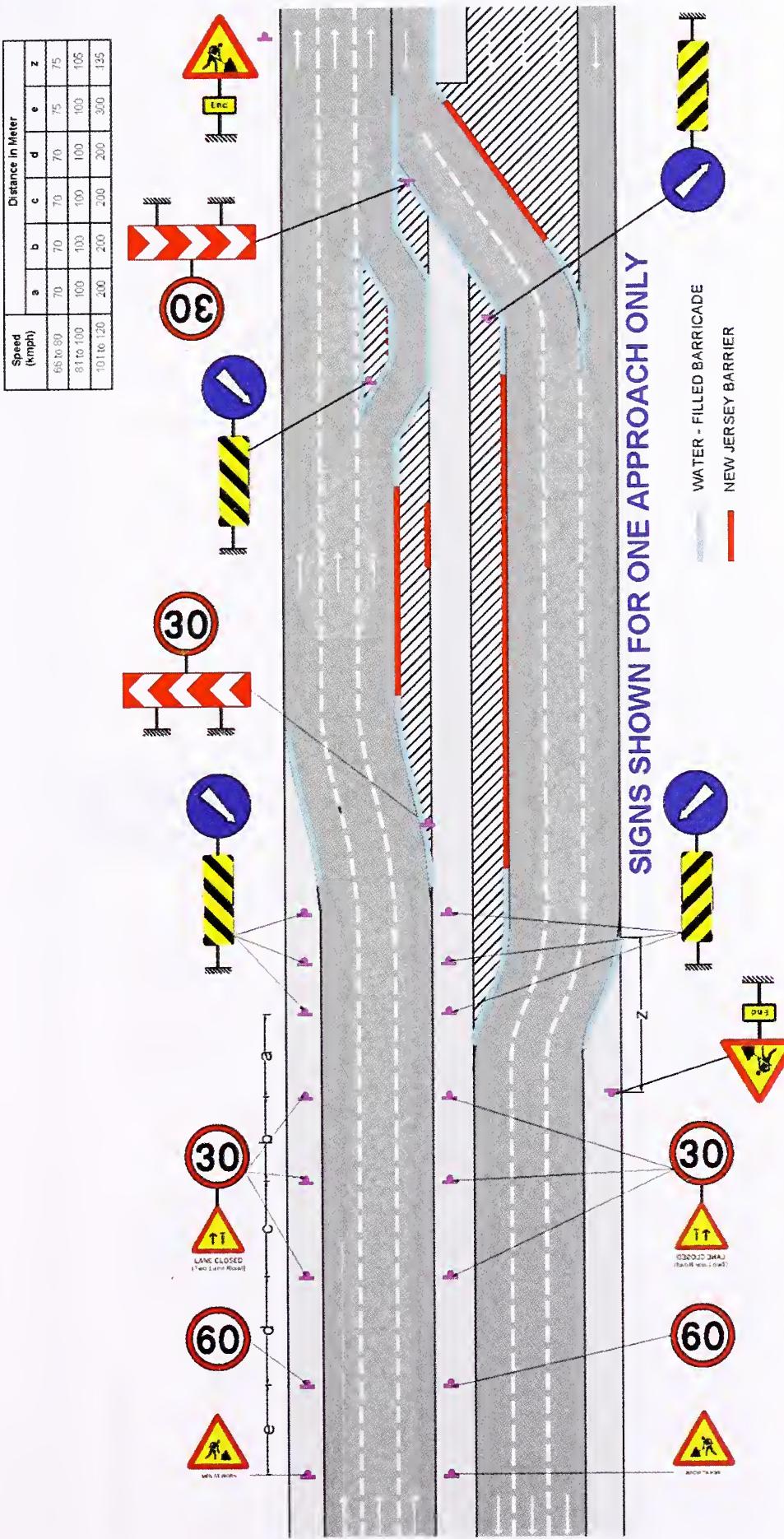


Fig. 10.25 Roadwork with Complicated Diversions & Contra Flow

APPLICATION :

The layout shown is applicable in a multi-lane highway where road works are in bits-and-piece like some works at median side and some in the center of carriageway involving even contra flow. Layout of signs and barriers would be as shown for one approach only.

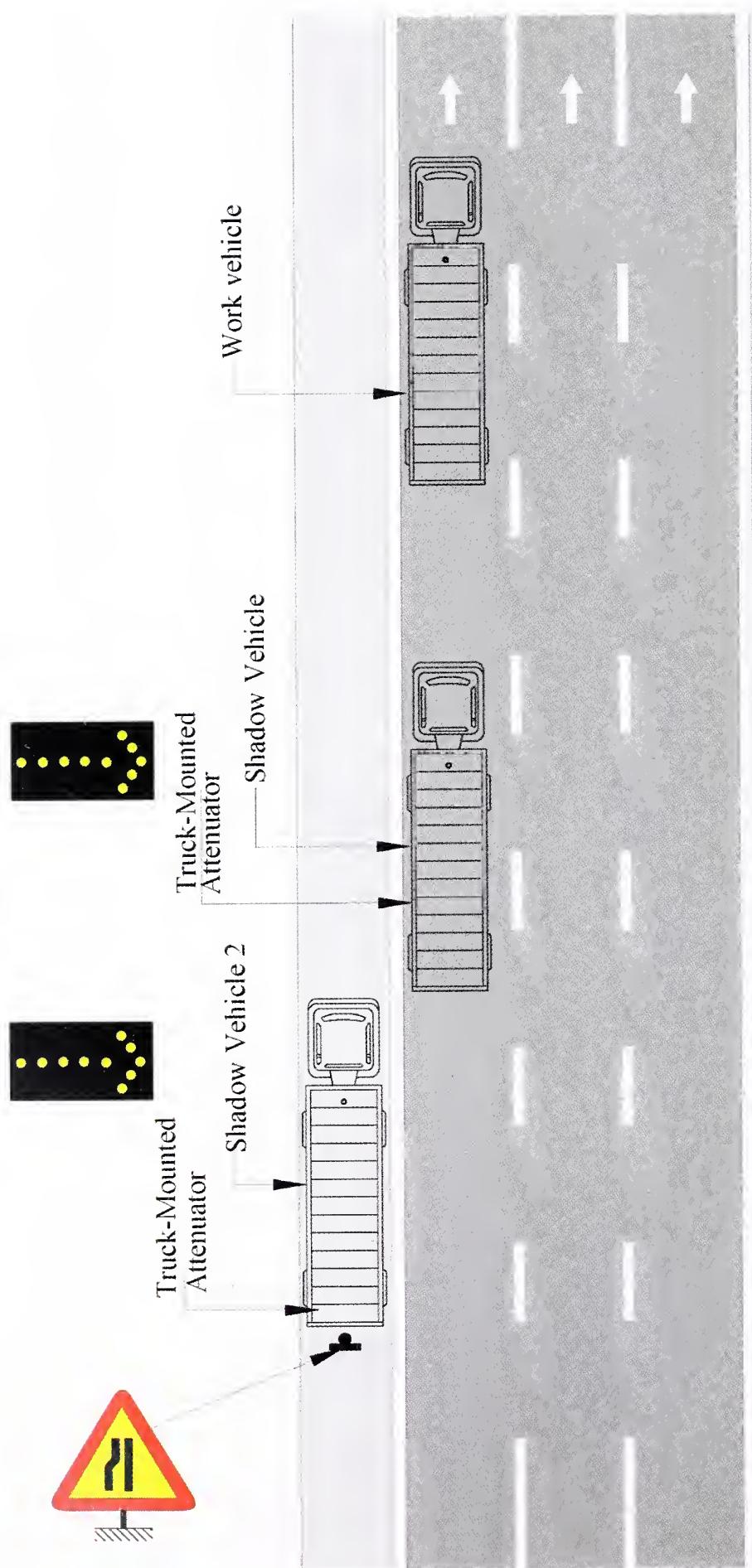


Fig. 10.26 Roadwork vehicle, Truck Attenuators & Shadow Vehicle

APPLICATION :

The layout shown is applicable in a multi-lane high speed highway showing work vehicle, shadow vehicle and truck mounted attenuators.

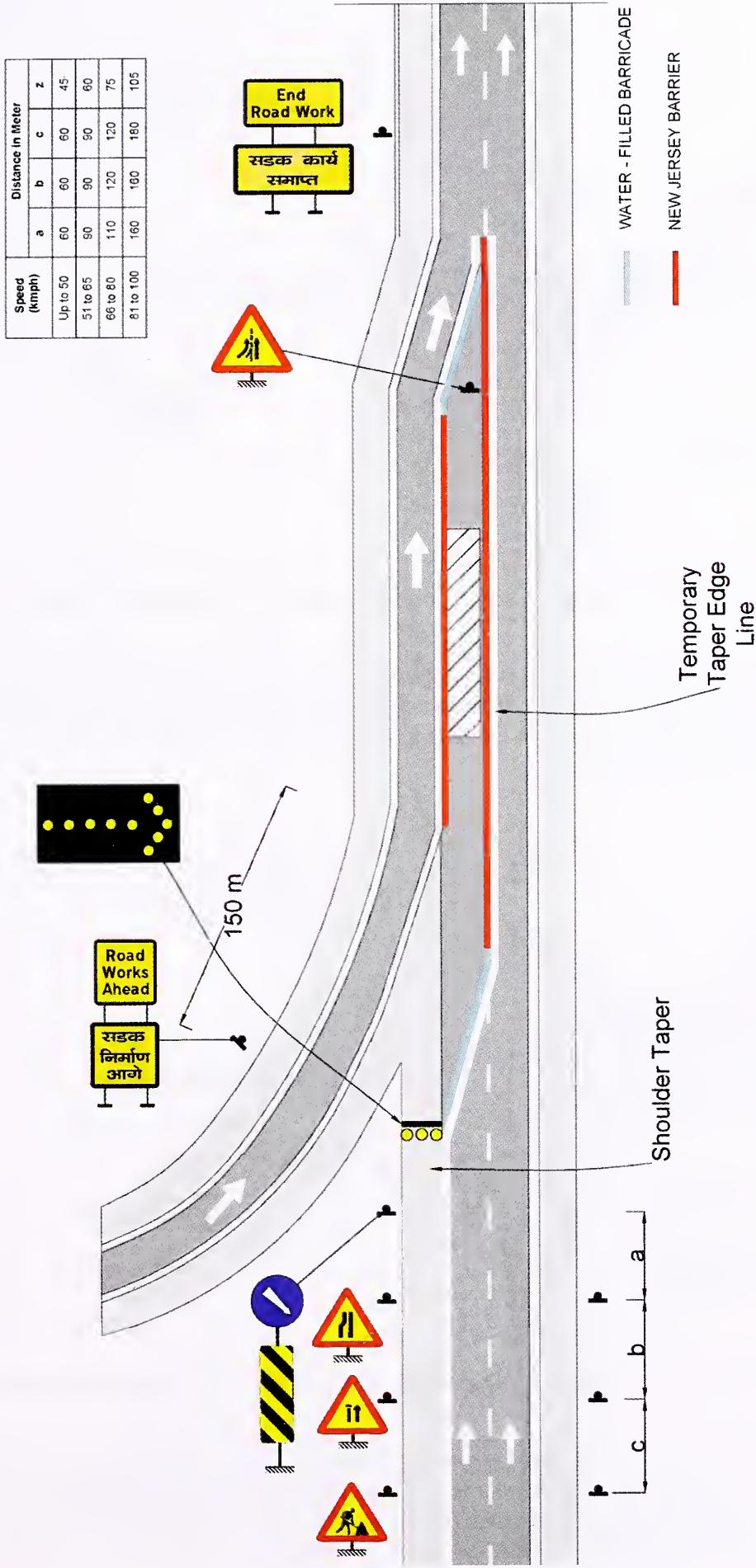


Fig. 10.27 Roadwork Near Entry Ramps with Arrow Panel Display

APPLICATION :

The layout shown is applicable for works involving curtailing of one lane for through movement warned with arrow displayed messages near an entry ramp.

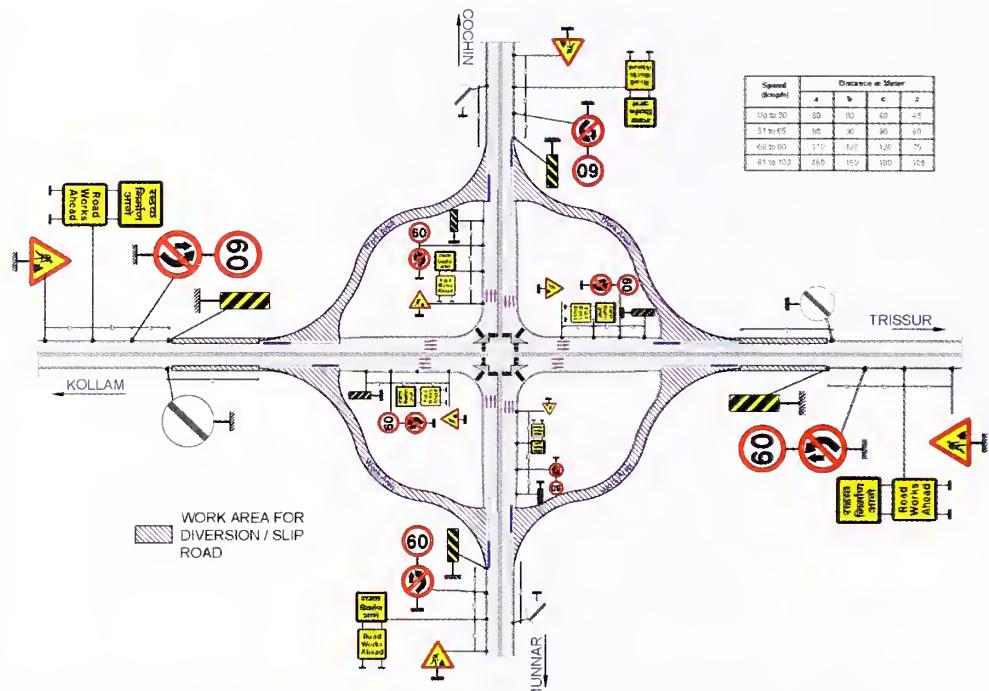


Fig. 10.28 Stage-1 of Developing Major Cross Road Junction to a Cloverleaf Interchange

APPLICATION :

In the first stage of the development of a heavily trafficked major road junction to grade separated full cloverleaf interchange, the slip road in four quadrants will be constructed along with acceleration and deceleration lanes for the two major roads. During this stage, traffic will continue to ply through the existing roads and the junction. Layout of signs and barriers would be as shown.

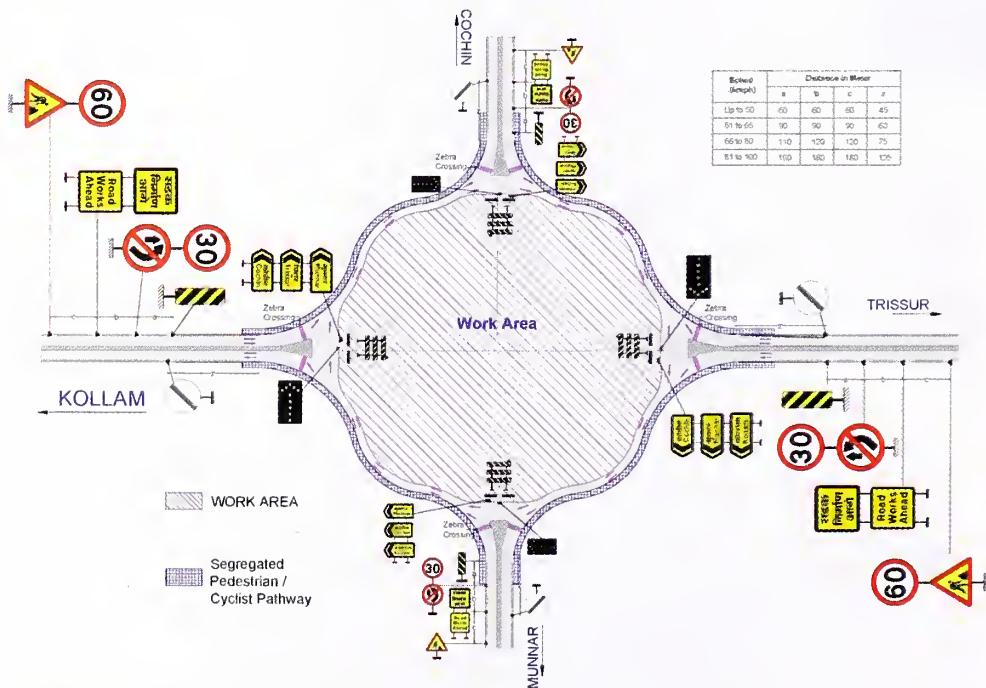


Fig. 10.29 Stage-2 of Developing Major Cross Road Junction to a Cloverleaf Interchange

APPLICATION :

Once the slip roads in four quadrants are constructed, in the second stage, the traffic will be diverted into these newly developed slip roads. The major road movements through the junction will now become circulatory system around the work area as shown in the layout, with proper direction information signs. During this stage, the central area will be taken up for construction of the structures and loops.



(The Official amendments to this document would be published by the IRC in its periodical, 'Indian Highways' which shall be considered as effective and as part of the code/guidelines/manual, etc. from the date specified therein)

**WARNING SIGN ON
HAND PADDLES**

