DESIGNING OF ROADS FOR SEGREGATION OF TRAFFIC INTO DIFFERENT SPEED ZONES:

Since ground level widening of road is achieved almost to the maximum available limit, future **planning should include constructing roads at level-I elevated (or underground) level.** The concept is different from that of flyovers/underpasses as it covers not just one intersection, but a complete section or stretch of road, **taking the vehicle from one congestion free zone to the other congestion free zone without having struggle through the slow speed traffic underneath or posing danger to the pedestrians moving there.**

This arrangement of traffic flow will have following advantages :-

i. Segregation of different types of traffic.

ii. Non stop flow of traffic on main arterial roads.

iii. Large scale reduction in fatal accidents.

- The planning of elevated roads can be justified for the reasons discussed below:

  Some of the facts that came to light in the road accident analysis done in the previous chapters are:

  I. **Delhi roads carry vehicles of different size, mass, speed and compactness/ Strengths** eg. HTV's, Buses, Tempo, Cars, Two-wheelers, Hand carts, cycle rickshaw, cyclist and pedestrians all on the same roads. Its like carrying Eggs, Stones, Plastic Balls, Nails and all types of vegetables together in a single bag, that too without any separate safety packaging.

  II. **Collusion** of two bodies on road **results in fatal accidents** if

  a. Speed is high and

  b. Mass of the impacting body is large.

  III. **29% (448 out of 1548) of the fatal accidents occurred on top roads** namely Ring Road, Outer Ring Road, Rohtak Road, GTK Road, Grand Trunk Road, NH-24, Mathura Road, NH-8.

  IV. **82.14% of these victims include pedestrians, two-wheelers and cyclist.**

  V. **65% of known offending vehicles include HTV's, Tempo and Cars**.

- The above mentioned roads are arterial life line of the city and help in reaching different parts of the city and criss-crossing the city.

Map 11.1 Delhi: National Highways, Ring Road and Outer Ring Road

Remedy: The **simple solution can be the segregation of the above categories of vehicles/road users as far as possible i.e. the heavy and high speed vehicles need to be isolated from most vulnerable-pedestrians, two-wheelers, cyclist. This can be done by making different speed zones for different types of vehicles.** The vehicles can be classified into following groups:-

I. Cars, Trucks, Tempos, Other State Buses **(High Speed And Heavy Weight) (40-70 Kmph)**

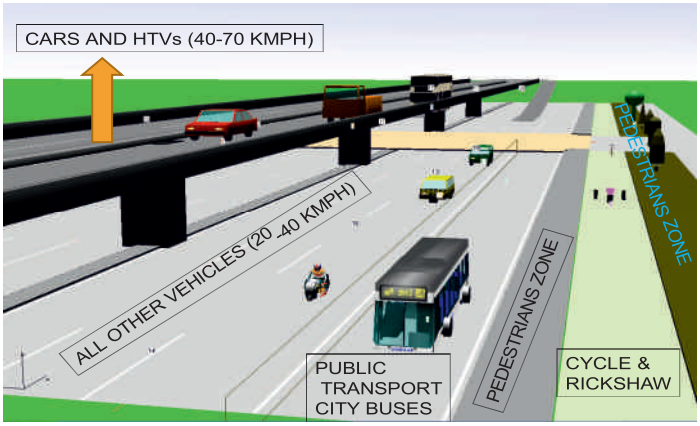
II. Cycles And Cycle-Rickshaws.

III. Public Transport (City Buses)

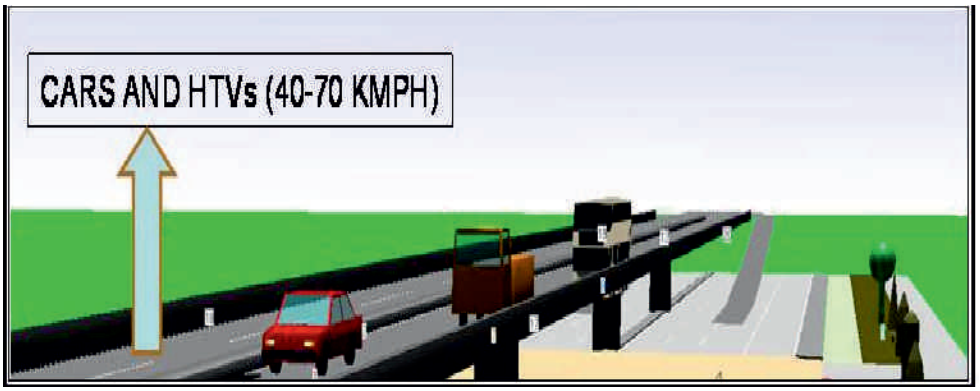
IV. Pedestrians.

V. And all others. (20-40 kmph)

The first group **(40-70 kmph) zone can be separated form the rest by making completely elevated corridors** (not just flyovers). The detailed road design is given below.

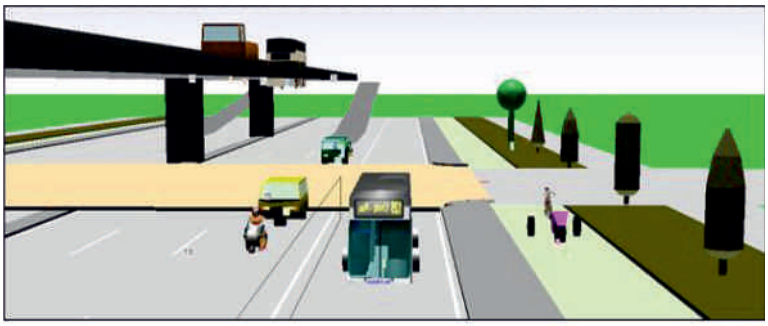


I. The Elevated corridor (Zone-1 40-70 Kmph)



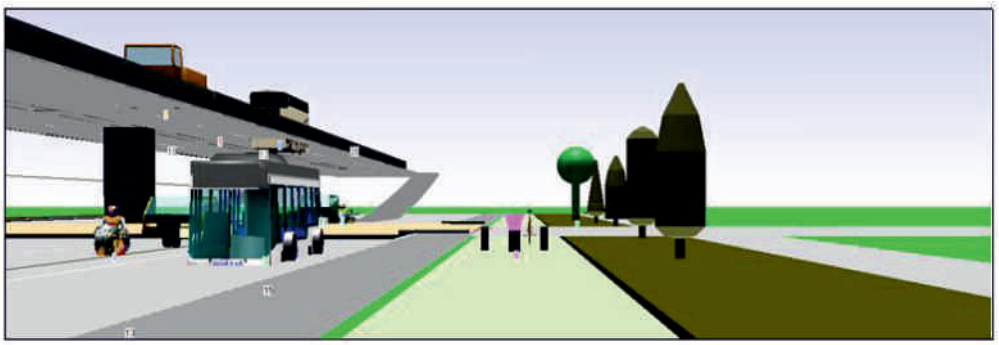
- It will **carry only four wheelers the cars, taxis, trucks, tempos, roadways and other state buses.**
- **Non city buses, no bus stands and no pedestrians.**
- No signals, no vendors, no encroachment, hence a virtual non-stopping zone.
- Hence no congestion. It will carry the main bulk of Traffic.
- Those intending to go left or right can get down before intersection.
- Separate slant arm of road to be provided to climb up or down of elevated corridor.
- The speed can be monitored by cameras fixed at different distances.
- No pedestrians, no two-wheelers, no cycle/rickshaws, hence no accidents of theirs.

II. The Public transport (city buses) section (zone-2)



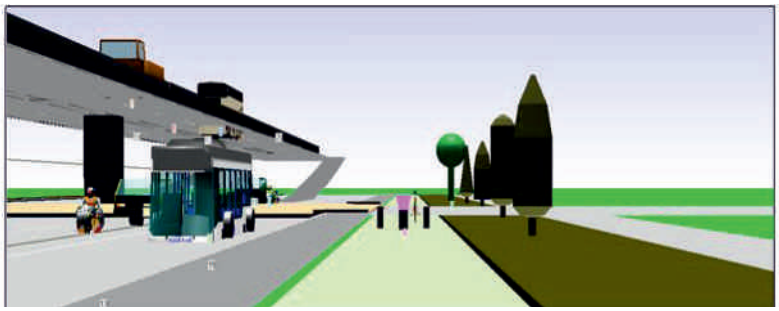
- It will carry **the public transport vehicles: DTC, Cluster, school buses and RTV's.**
- To be maintained more or less on the **BRT type arrangement.** Separate zone for public transport, **but on the left side of the main road separated by the grill from the main road** on the ground level.
- Normal signal cycle as for other vehicles on the road. But will allow free flow as separated from the main bulk of traffic.
- **Entry and exit of passengers only at the bus stands.**
- No other vehicles allowed, so virtual safe public transport zone.
- No two-wheelers, no cycle/rickshaws, hence no accidents of theirs.

III. The Cycle and Cycle-rickshaw zone (zone-3)



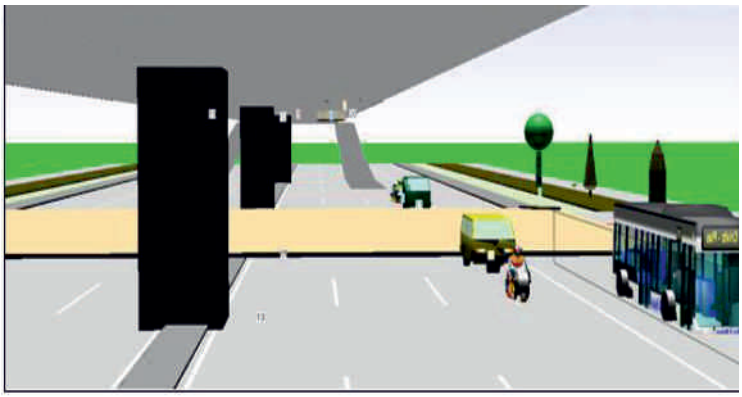
- Same on the style of BRT corridor on the left.
- It will carry **only cycles and cycle-rickshaw** safely (5% of victims).
- Shall follow the normal signal cycle at intersection.

IV. The Pedestrians zones



- On the **left of bus bay and on the left of cycle bay.**
- Pedestrian's path on the **opposite sides of the road to be connected by foot over bridges** passing under the elevated corridor.
- Foot over bridges to be provided if the normal intersection is far from a potential road crossing point.

V. The miscellaneous bulk zone (zone-4, 20-40 Kmph)



- It will **carry all the miscellaneous bulk of Traffic.**
- **To keep safe, the two-wheelers are to be kept in it.**
- **All, including the vehicles descending from elevated corridor for left or right turn, have to follow the speed of the zone.**
- The **intersections are to be made with table top and roughened stones to keep speed down.**
- Even if there are chances of accidents, the chances of it being fatal should be less.
- Normal signal cycles at intersection for all.
- **No vendors space (either on right or left) hence no encroachment hence smoother flow of traffic.**
- This arrangement will help in :
  I. **Reducing accidents** by separating the major victims from their aggressors. If implemented on top arterial roads, **this can save 300-500 lives per year.**
  II. **Increase the mobility of traffic**, particularly on the major roads.
  III. **By-pass the heavy traffic** which unnecessarily burdens the city roads.
  IV. **Improve the look of the capital city.**
  V. **Reduce congestion and pollution.**

MEASURES TO REDUCE TRAFFIC CONFLICTS (AND HENCE CONGESTION, POLLUTION AND ROAD ACCIDENTS)

- **Principle : -** Reduction in conflict (perpendicular and head-on) in traffic movement and maintaining continuity of traffic flow.

1. Redesigning of intersections by removing signals:

- **Shortcomings/ disadvantages of traffic signals:-**

1. 75% of traffic remains static:

Consider an intersection having traffic flow of equal volume from all the four arms. With the normal signal cycle, traffic coming from any one direction can only be discharged at a time. This means that 75% of traffic will remain halted and only 25% of traffic shall move at one time.

This can happen even for the 4 cars approaching intersection from four different directions. 3 will have to wait for different timings and only one can move. Thus, signaled intersection can never make zero congestion, unless there is no traffic at all.

2. Low traffic discharge speed:-

In continuation of above assumption, if the maximum speed of movement of traffic flowing from the green signaled arm is 30Km/hr, the average speed of movement is (since the traffic started from rest)

$$\text{Average Speed} = \frac{(30+0)}{2} \text{ Km/hr.} = 15\text{Km/hr.}$$

But the actual speed of the whole traffic at the intersection (assuming equal traffic on all sides) is one fourth i.e 3.75 Km/hr

Actual Speed of discharge at

$$\text{intersection} = \frac{(15)}{4} \text{ Km/hr.} = 3.75\text{Km/hr.}$$

That is why it takes too much time to clear and normalize the traffic at signaled intersection.

3. Vehicle starts from zero speed:-

It also takes more time for a vehicle to start and pick-up from zero speed.

4. Adjustment of signal timings for different arms:-

The signal timing can never be according to the actual volume of traffic, in the four arms of the intersection, unless it is controlled manually. Many times vehicles on the three sides have to wait, even when the intersection is clear and there is no vehicle on the fourth green signaled section of the road. (This also prompts drivers to jump the red light and may cause accidents)

5. Synchronization of traffic signals can never be perfect:-

If there are traffic signals at small distances on a road stretch, say at every half or one Km of road, there is always a problem of synchronization of traffic signals. It is difficult to achieve perfect synchronization of all the consecutive traffic signals for all volumes of traffic.

6. Most Accident Prone Zones are intersections:-

As per the study conducted by Accident Research Cell, among the 108 Accidents Prone Zones identified during year 2016, 65 are the intersections of different types (normal intersections, T Points, Y Points etc.). Classification of above Accident Prone Zones into their types with their numbers is listed below:-

i. Multi-level intersection (26).
ii. Intersection (17).
iii. T-Intersection (13).
iv. Road stretch (12).
v. Multi-Intersection (9).
vi. Bus stand (8).

vii. Exchange hub (7).

viii. Metro station (5).

ix. Highway village (5).

x. Flyover (3).

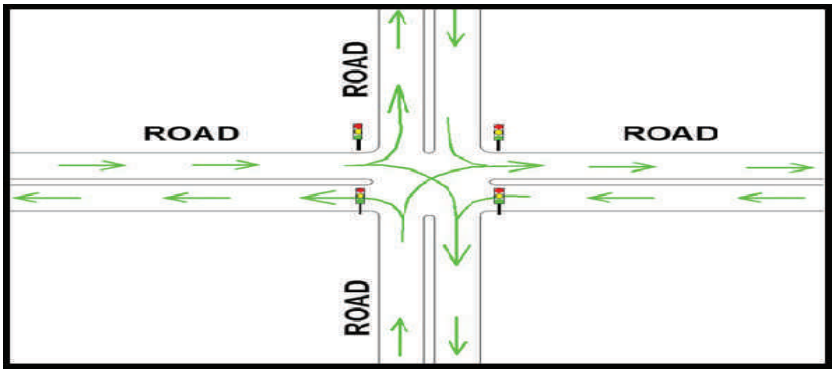
xi. Hospital (3).

There is only one round about among these accidents prone zones. One of reason is that it prevents the right angled conflict of vehicular movement as there is no straight crossing by the vehicles across the intersections. Hence, the Vehicle slows down at it.

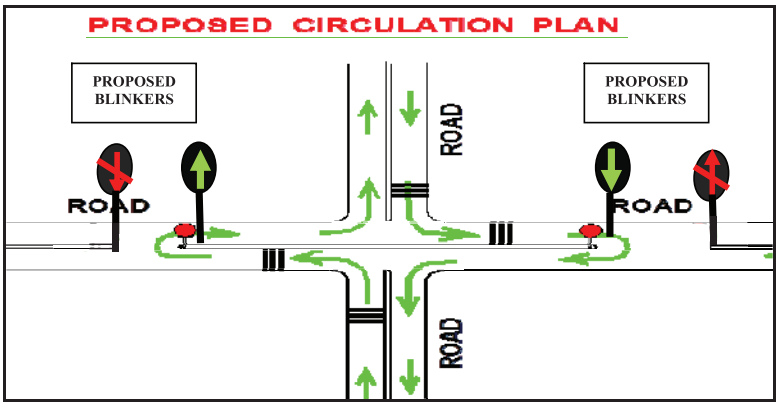
Alternative Method of Traffic Movement/ Proposal for continuous and non-stop movement of traffic at intersections and junctions (What can be done?)

- **The Concept of Oval Round About:-**

Let us consider a normal intersection of two roads (with medians) meeting each other perpendicularly. In the conventional intersection, as shown below, there is an open area for crossing at the junction point of two roads. Traffic crosses this area for moving in all the four directions. This area has conflict of traffic coming from all directions. This conflict is prevented by making it signaled crossing, by allowing flow of traffic from one side at a time.



Now consider another arrangement of this intersection where the crossing at the intersection is closed for one of the roads (minor one) by the median of the major road and opening in the median are provided at a short distance (50 to 500 mtrs) depending on the volume of the traffic as given below.



As shown above, traffic can move in all directions by taking 'U' turn at the opening provided on the two sides, without conflicting directly at the intersection. Blinking signals  can be provided at the cuts to clarify the direction flow of traffic allowed at cut provided in the median.

Advantages

1. 100% traffic in motion simultaneously:

The advantage of this arrangement is that there is continuous flow of traffic from all sides simultaneously, without halting of traffic coming from any arms.

Thus, even if the actual average speed of movement of traffic on two roads is 20Km/hr and 10 Km/hr on the two intersecting roads the actual average speed of movement of whole traffic moving at the intersection (assuming equal volume of traffic from each side) is

Average speed of movement of whole traffic moving at the intersection

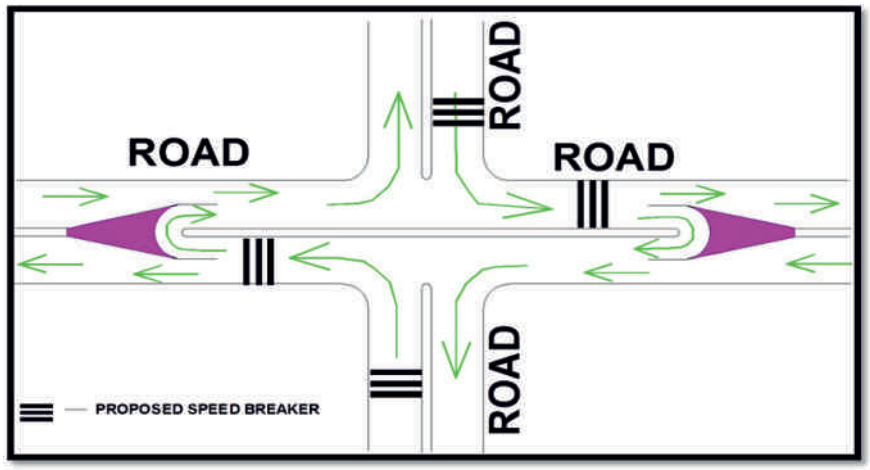
$= \frac{(30+0)}{2}$ Km/hr. =15 Km/hr.

This is much higher than the conventional signal controlled flow of traffic where average speed of whole traffic crossing the junction was around 3.75 Km/Hr (even with the traffic moving at a speed 30 Km/hr). Thus, this gives better clearance of traffic and reduces congestion. (Similar arrangements of traffic flow at intersection have worked effectively well during construction of elevated corridors on Outer Ring Road at Deepali Chowk and Jaipur Golden Red Light etc.).

2. **Second advantage is that it reduces the chance of head-on collision to zero** (unless there is wrong side movement) and also reduces the chance of perpendicular impact. The vehicle approaching the intersection from minor roads has to slow down to cross it. In fact, it virtually acts as roundabout of different shape.
3. **There is no need of unnecessary halting of traffic** from three sides when the intersection is vacant.
4. **Reduces red light jump violation.**
5. **Acts as self regulator** depending on the volume of traffic coming from different sides. There is no need to change signal timing for different arms of intersections.
6. There is almost continuous flow of traffic from all directions and no vehicle halts to zero speed at the intersection.

Precautions to be taken while designing oval round abouts :-

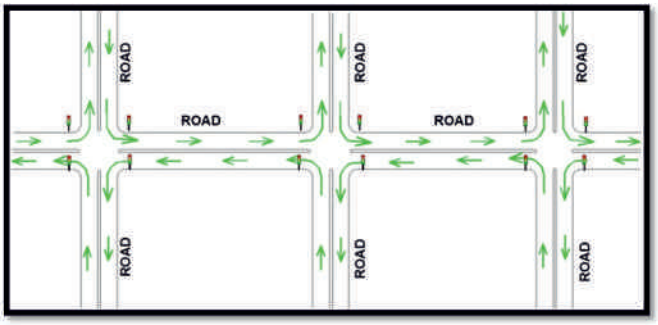
1. **It must be ensured that there is no direct opening of any minor road, or any petrol pump or school or society close to the cut provided in median** as this could lead to wrong side or transverse movement of vehicles. This can reduce its effectiveness. Such direct flow should be prevented.
2. **Protection cover can be provided for safe 'U' turn of vehicles,** if it is a major road. Similar system is already working at many intersections for eg. Under Outer Ring Road elevated corridors at Jaipur Golden, at Bhajan Pura on Wazirabad Road and at Brar Square on Ring Road.
3. **Speed Calmer can be provided where the minor road meets the major roads and a little before the cut for the 'U' turn** to slow down the vehicles. (Speed-calmers to be preceded and succeeded by the pseudo-breakers. This acts as better warning than just warning sign boards.)



4. **If the pedestrian movement crossing the intersection is high, "all vehicle red and all pedestrians green" signal can be introduced** at the intersection for 20-30 seconds, after a 3 or 5 min. interval, for pedestrians to cross for all directions simultaneously. Timing of signal depending on the volume of pedestrians crossing the intersection.
5. **Routes of some of the buses may be modified to ensure the smoother flow of traffic.** It has to be ensured that the large buses do not halt the complete traffic while taking 'U' turn. If the frequency of bus movement is high, the route can be extended up to the appropriate spot so that it can turn smoothly.
6. **Similarly, the turning of heavy goods vehicles to be allowed from the appropriate spot only** (not at any U turn) where the road is wide, to avoid unnecessary halting of whole traffic.
7. **Numbers of cuts for right turn to be kept limited** and at proper reasonable distance, say at least ½ a km even on minor roads. (And such cuts not necessarily provided for every intersection or junction of roads).
8. **No parking/halting of public transport vehicle near the cut to be done to maintain the continuity of traffic flow.** Any parking of vehicle or halting of public transport vehicles for boarding and de boarding, clustering of TSR looking for passengers shall hinder the free flow of traffic.

2. **Making stretches signal free (without building flyover and underpasses).**

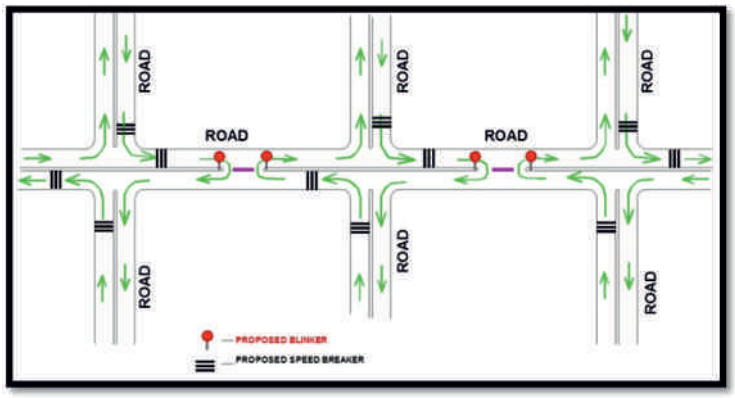
   Consider a road stretch of few kms having intersections with light signals at every ½ km, 1 km or even lesser stretches of road. Such road can be between two major intersections joining two major roads eg. Rohtak road between Punjabi Bagh Chowk and peergarhi or roads inside Dwarka and Rohini eg K.N. Katju Marg, Road no 41 etc. These all have signaled crossing at small distances. The existing road stretches can be as depicted as given below.



There is normally synchronization problem between the traffic signals of consecutive intersections and the vehicle has to stop more or less at every junction. This is the case with the conventional form of junction we are presently using.

Roads with normal intersection crossing were good, when the majority of vehicles were in primitive form i.e. mostly slow moving traffic, with intermittent motorized vehicles. With the increase in the number of motorized vehicles we transformed the same intersections into signaled intersections to create a system to prevent collision/ accidents and to provide turn by turn discharge of traffic from four arms, preventing interlocking/grid locking of traffic at intersection. This worked well till the increase in the vehicular population was moderate. Now, when the increase in vehicles is enormous, which is mostly motorized vehicles, there is need of developing a system which can allow continuous flow of traffic from all the arms of intersections simultaneously. The stopping of vehicles at any section can cause congestion within minutes. One solution that we worked out was by constructing flyovers and underpasses. But this cannot be done at every intersection and on every road. Also, it does not do justice to movement of traffic on all the arms and in all the directions, unless the intersection is modified with many loops like that of 'Dhaula Kuan' or 'Mukarba Chowk'.

Let us consider another arrangement of traffic flow in which all these red lights at each intersection are removed and all the intersection where the minor roads meet the major road is closed by the median of the major road. Thus, stopping direct transverse movement of traffic from the minor road, across the major road. Instead a cut is provided at a distance as in the oval roundabout. The road stretch can be depicted as below.



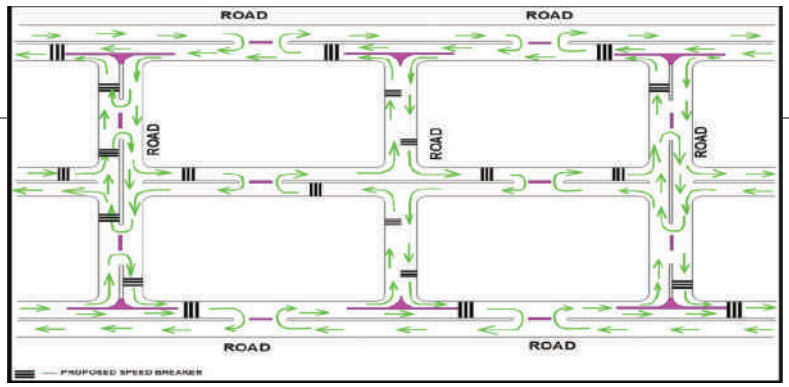
This will allow the continuous flow of traffic on the main road. Traffic at all the intersections will keep on moving and there shall be continuous discharge of traffic from all the arms of the intersections. It is in line with the basic principle of traffic flow "the movement of traffic in desired direction will always ease the traffic congestion and it is the stopping of traffic that increases it".

This can first be tested on small colony roads in Dwarka and Rohini for eg. K.N. Katju Marg or Dev Prakash Shastri Marg, Ridge Road etc.

If found successfull, the system can be extended to other roads.

The directional flow of heavy traffic (i.e. heavy flow of traffic in one direction) during morning hours and is reverse direction during evening peak hours will assist smooth flow of traffic in this type of traffic flow arrangement.

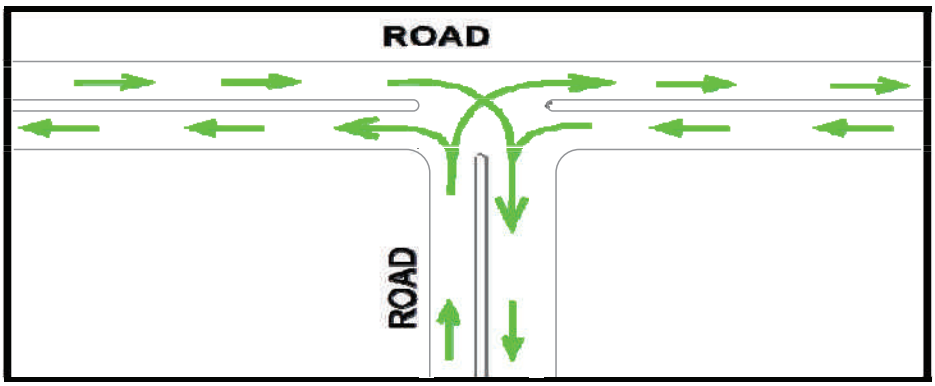
This way complete grid can be made allowing continuous flow of traffic on all roads without signals at intersections (as in New Delhi area on most roads.)



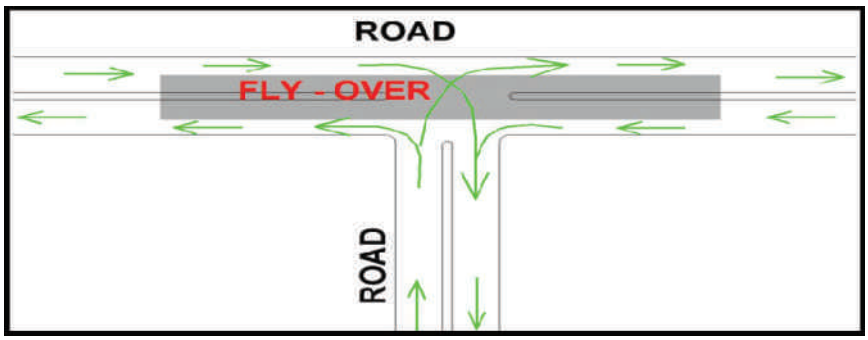
ROAD GRID STRUCTURE

3. Flyover loops at 'T' point

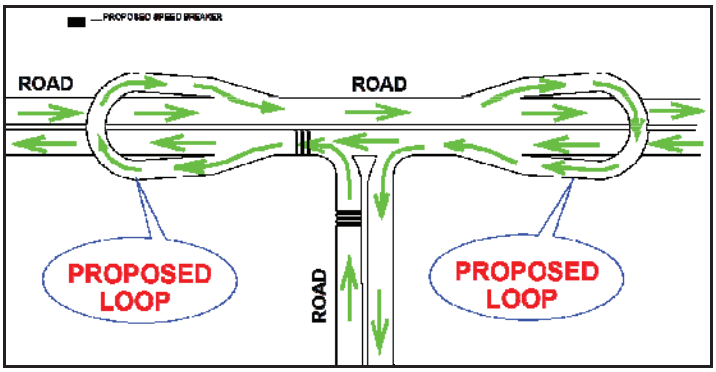
A normal 'T'-point intersection has three directional conflict points for the traffic moving in its three arms. These conflicts are prevented by providing traffic signals that allows turn wise movement of traffic at different arms of intersection. Violation by vehicles from any side may cause collision and hence an accident. The conflicted movement is shown below.



Using the conventional solution we think of making flyovers or underpasses on the main road. But this does not prevent the ground level conflicts; hence such multi-level intersections continue to remain accident prone zones.

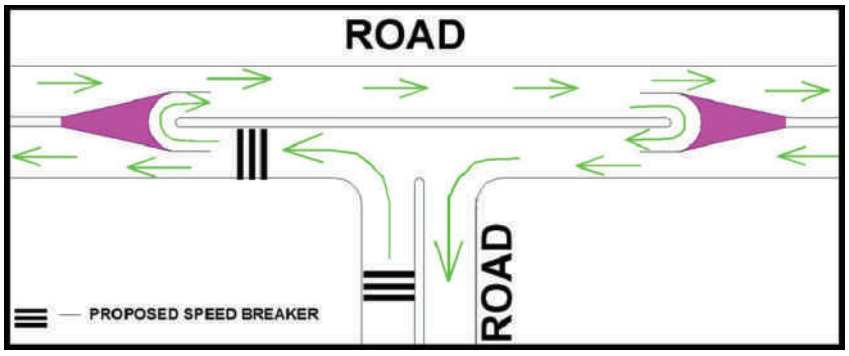


Instead, if the type of arrangement of traffic flow as depicted below is put in place, it shall reduce the conflicts of traffic movement by building just two flyover loops and shall ensure continuous flow of traffic from all the three arms of intersections.



The size of loop depends upon the volume of traffic at the intersection. This type of design can be good for T-points like Bhairon road-Ring road T-point and Majnu ka tila T-point on Ring road.

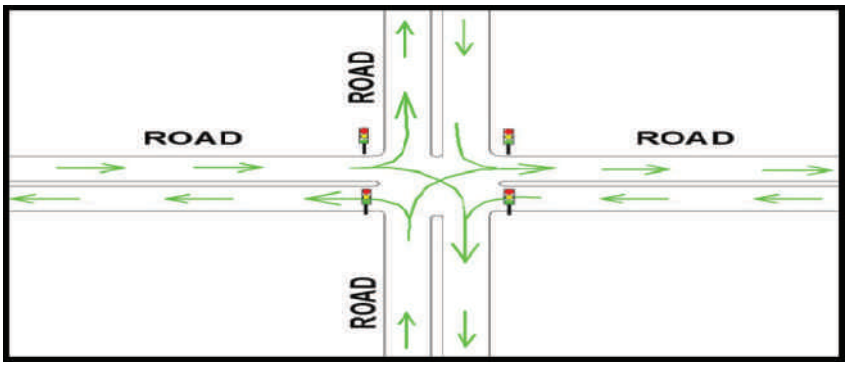
The other type of design of T-point intersection to give a continuous flow of traffic without making flyover loops is shown below. It needs greater stretch of road for vehicle to change the lanes before taking 'U' turn.



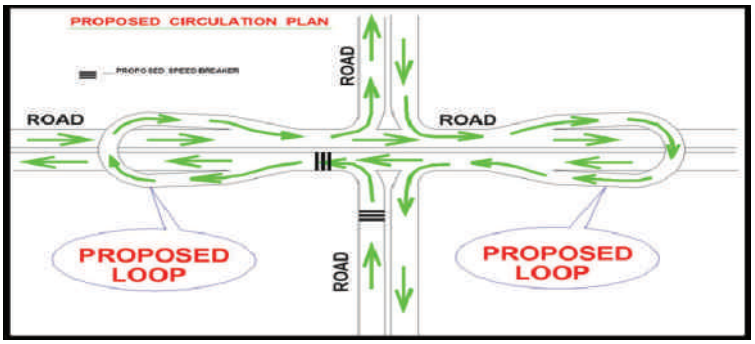
This type of arrangement needs more space and some protection design for vehicles taking 'U' turn, if it is high-speed corridor.

4. Intersection having four arms:-

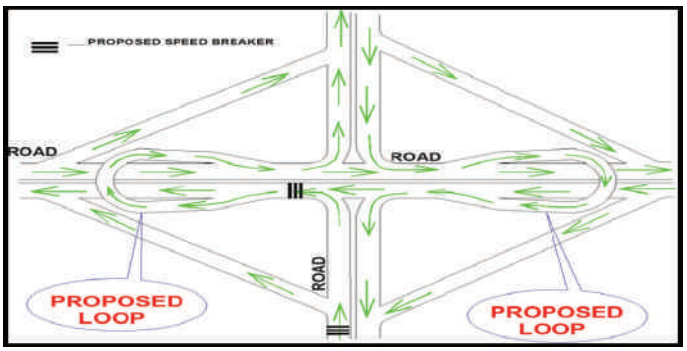
Consider the intersection having four arms flow of traffic movement. There are conflicts at the common area of the intersection in the movement of traffic from all the four arms. This is controlled by the signaled movement of traffic. Otherwise it may cause collision that may lead to accidents.



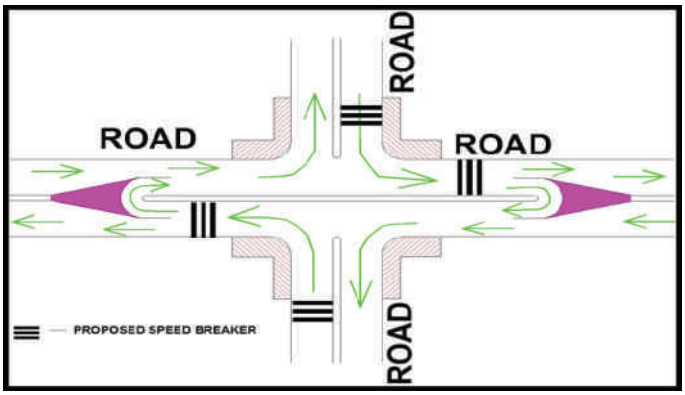
At such intersections traffic flow can be streamlined by constructing two flyover loops on the major road as in the previous case to allow the smooth flow of traffic at the intersection. Again the size of the loop depends on volume of the traffic at the intersection.



Separate free left turns can be provided to further reduce conflicts and smoothen the traffic movement.



The other arrangement can be of 'U' turn at the ground level, which needs greater stretch of roads for changing lanes safely and needs more space and some protection design at the place of 'U' turn, if it's a high speed corridor. The design of intersection is given below. Such intersection design can be helpful for continuous flow at traffic at intersection like Madhuban Chowk and Peeragarhi.



The places where there is heavy pedestrian movement across the intersection, an all red signal for vehicles and all green signal for pedestrian can be introduced for pedestrians to cross the intersection, with a gap of 3 or 5 minutes as per the requirement of the intersection. This can be done till better and safer road crossing facilities are developed for the pedestrians. Safe waiting platforms can be designed for pedestrians at the four corner sides so that pedestrians do not interrupt the free flow of traffic and become victims of some accident.

It is to ensure that there is continuous flow of traffic in the vicinity of intersections. Any parking of vehicle or halting of public transport vehicles for boarding and deboarding, clustering of TSR looking for passengers shall hinder the free flow of traffic. Separate/proper halting space to be developed for its.

5. Developing pseudo Two-wheeler tracks:-

There are around 61 lacs registered two-wheelers in Delhi. Their percentage share is around 62% of total vehicular population of Delhi. The percentage share is increasing every year.

Two-wheelers have been victims in around 36% of fatal road accidents during the year 2016. Two-wheeler riders were victims in 572 fatal and 2911 total accidents during the year 2016.

The percent share of two-wheeler as victims is increasing every year.

Table 11.2

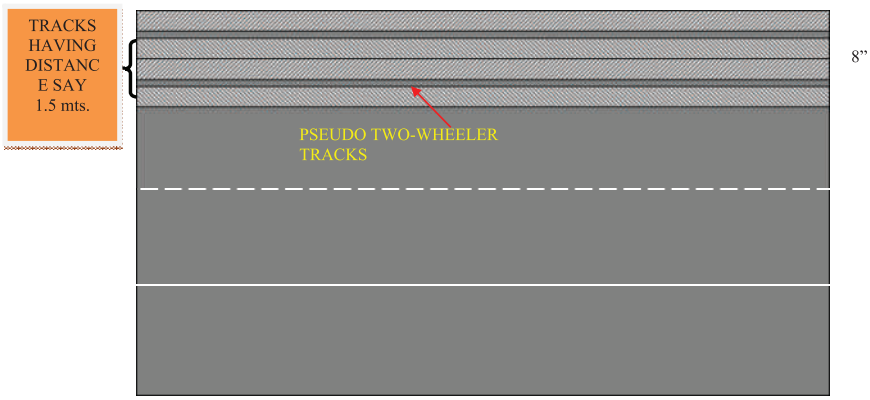
YEAR	TWW FATAL (victims)	TOTAL FATAL	PERCENTAGE
2012	560	1822	**30.73 %**
2013	596	1778	**33.52 %**
2014	555	1629	**34.06 %**
2015	553	1582	**34.95 %**
2016	572	2911	**36.95%**

There are very few safety gadgets available for the two-wheeler riders. Though, a lot of research work has been done for the safety of the passengers in the cars, no solid protection is available for safety of two-wheeler riders, except for the helmet. Let it be anyone's fault, when there is impact, collision or even touching, it is the two-wheeler rider who remains at the receiving end. It results either in fatality or comparatively more severe injury to the riders. While the normal touching or brushing of vehicles results in only damage to vehicles, in case of two-wheeler it ends in injury or fatality.

With the ever-increasing population of vehicles on road, there is a struggle for space on road. Safety of two-wheeler riders has always been a cause of concern as, till now, no complete segregation for two-wheelers has been designed on the roads and no definite lane has been ear-marked for two-wheelers. On the left lane they are at the mercy of heavy commercial vehicles, while on the right they have to compete with high speed vehicles and in the middle lane they are exposed to the lane changing vehicles.

To secure these two-wheelers they can be segregated from other vehicles by developing pseudo two-wheeler tracks. These tracks can be designed using pseudo breaker strips as in the design given below.

PSUEDO-TWO WHEELER TRACKS MADE OF PSUDO BREAKER STRIPS



*The dedicated two-wheeler track should only be wide enough to accommodate the safe movement of two motorcycles/scooters at a time (simultaneously), without brushing each other but should not accommodate the axle length of four-wheeled vehicles so that four wheelers do not dare venture into the two wheeler track.

Where there is heavy two-wheeler movement or there are more two-wheeler accidents, such track can be placed on the extreme right lane of three or four lane road.

This arrangement shall allow disciplined straight movement of two-wheelers in two designated lines. It shall hinder their zig zag movement and also shall deter other four wheeled vehicles to normally enter this section (as there will be bumpy ride for all other vehicles except for the two-wheelers). At same time all vehicles can move in this area also, when there is congestion or heavy traffic in this section of road.

It can first be tested in small sections of two-wheeler accident prone zones like Madhuban Chowk underpass etc.

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