Case Studies on Road Safety Improvement Works

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Road Safety Improvement of the stretch from Km 0.00 to Km 1.40 of NH-80 including improvement of major junctions in the state of Bihar
Existing road environment of Mokama junction on NH-80 in State of Bihar
Existing Carriageway of Patna-Munger stretch varies to a large extent from 7m to 15m without any dividers/ pavement markings / signs etc. Existing geometry is very poor with curve radii varying from point to point with irregular alignment / carriageway edge. Major traffic movement is from Patna side to Munger side whereas this stretch is getting interrupted with three undeveloped and unregulated junctions thereby leading to large number of conflict points. There is no streamlining of traffic movements. All left & right turning movements are taking place on all legs at all the junctions leading to confusing traffic conditions. Bata Chowk is a “T” Junction without any channelization with mixed traffic conditions ranging from urban traffic to long distance truck traffic.
Existing road environment of Mokama junction on NH-80 in State of Bihar Contd..

No road signs/markings/hazard markers were existing to guide and streamline the traffic. The location being very near to Mokama town, large scale pedestrian movements along and across the Roads are present without any pedestrian facilities. The area is poorly drained with water logging adding to the existing unsafe conditions. Large extra paved areas are present at the junctions leading to irregular conflicting traffic movements. Though the stretch has poor geometric / junction conditions, there are no traffic calming/speed regulation measures. There are isolated buildings / structures all along different legs leading to entry of vehicles to main highway in irregular manner.
Proposed remedial measures to the safety concerns at Mokama junction on NH-80 in State of Bihar
Geometry of the major traffic stretch from Munger side to Patna side and vice-versa is improved with a fluent radius of 200m and with 4-lane divided carriageway. Right turning from Barauni leg to Munger leg is prohibited with a continuous median across Junction-2 (as there is an alternate facility of right turn for this traffic from Barauni leg at Junction-1), thereby reducing the conflicts. Geometry of the legs from Junction-3 to Junction-2 and Junction-4 to Junction-1 has been improved with a radius of 150m with fluent alignment. Junction-1 is improved by providing properly shaped median islands and channelizing islands thereby removing excess paved area which was leading to irregular traffic movements. 5.5m turning lanes are provided for all turning movements including right turn waiting lanes.
Proposed remedial measures to the safety concerns at Mokama junction on NH-80 in State of Bihar Contd..

Turning radii of 10m to 30m are provided as per feasibility to allow easy turning by different categories of vehicles. This area being a semi-urban area located near Mokama town, there is substantial pedestrian traffic. To cater to this traffic Zebra Crossing with pedestrian pathways across channelizing islands at carriageway level are provided. All the pedestrian paths are designed keeping them at right angles to traffic movement with shortest length making them clearly visible to traffic. Medians are cut open to provide pedestrian pathway across the median at carriageway level. Median opening of adequate size is provided to accommodate required turning radii. To avoid Jay crossing of pedestrians across the median at random locations, 1.5m high railing has been provided on the median with gaps at Zebra Crossing points.
Proposed remedial measures to the safety concerns at Mokama junction on NH-80 in State of Bihar Contd..

For safe longitudinal movement of pedestrians footpath-cum-drains of 2m width with 1m high railing on traffic side have been provided. Openings in pedestrian railing were given only at Zebra Crossing points. Chevron markings, turning arrows centre line, edge line and traffic lane markings along with road studs were provided to streamline the traffic. Median islands of sufficient length were provided at the junction with divided carriageway. Two way & one way hazard markers were provided at the ends of islands to warn road users about the presence of island. Mandatory signs of “Speed limit”, “Right turning prohibited” and cautionary signs of “T Junction ahead” have been provided at appropriate locations while avoiding clustering of signs.
Apart from speed limit signs on the long stretch with gentle curvature, Bar Code type pavement markings as a speed reduction measure have been provided. The existing carriageway was joined with the widened carriageway at the junction with suitable taper of 1in 10 or gentler. Junction-2 has been made a “Left in” “Left out” junction to reduce conflicting movements. Channelizing islands with appropriate shape have been used to cover up excessive paved area which streamlined the traffic movement. Road signs, markings etc., are provided similar to Junction-1. In case of Junction-3, local traffic movement from Mokama side to Munger side and vice versa is large, due to which, straight traffic lane has been separated out from the right turning lane.
Proposed remedial measures to the safety concerns at Mokama junction on NH-80 in State of Bihar Contd..

Channelizing islands of proper shape, carriageway level pedestrian paths across islands, shortest Zebra Crossings, footpath-cum-drains, pedestrian railings, median railings 1.5m high to prevent Jay crossing by pedestrians, median openings of adequate size, road signs & markings are all provided similar to other junctions. Junction-4 has also been developed with channelization, right turn waiting lanes, signs, markings etc., similar to Junction-3. With these improvements the safety concerns in the existing layout got addressed improving the safety by design.
Road Safety Improvement work from Km 1+980 to Km 5+190 on NH-17 including widening, U-Turn facilities, junction improvement, footpath-cum-drain etc. in the state of Goa
Existing road environment of stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa
Existing NH has an undivided 9m carriageway. One cross road is joining on LHS and two cross roads in the form of 'Y' Junction are joining on RHS in a staggered manner with a short stagger length. Turning radii, signs/markings & turning lanes are not existing at the junction location at km 2.30. There is excessive paved area at the junction locations leading to complex irregular traffic movements. There are no pedestrian facilities or drainage arrangements at this location. There is sufficient land width available for improvements at the junction location. The stretch is in rolling terrain with upward gradient towards Cortalim.
Proposed remedial measures to the safety concerns on stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa
Proposed remedial measures to the safety concerns on stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa Contd..

Within the available land width, existing carriageway has been widened to 4-lane divided carriageway near the junction with a central tapered median with right turn storage lanes of 3.5m width. Lane markings have been provided to demarcate different lanes. Separate Left turning lane is provided for the left turning traffic. All the cross-roads joining the NH have been provided with median island and 5.5m carriageway on either side. One way object hazard markers have been provided at the tips of central median islands to warn the road users about the hazard. Chevron markings, straight and turning arrows have been provided to guide and streamline the traffic at Junction-1. The cross-roads being minor with no pedestrian activities, Zebra crossings have not been provided.
Existing road environment of stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa
Existing road environment of stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa Contd..

There is no pedestrian facility and drainage arrangement for the stretch.
Proposed remedial measures to the safety concerns on stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa
Proposed remedial measures to the safety concerns on stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa Contd..

Footpath cum drain contd.
Existing road environment of stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa
The stretch is in a rolling terrain with upward gradient towards Cortalim. The carriageway width is varying from 9m to 12m without any central median. Other cross-roads are also joining at acute to right angles without any turning radii, channelizing islands etc. There are large paved areas at the cross road locations leading to irregular traffic movements. There are no signs/markings. This stretch is the approach to Goa Medical College and Dental College complexes laying on RHS and LHS of the main NH. The Junctions need proper channelization, provision of turning and waiting lanes etc. to streamline the traffic towards Dental/Medical College complexes. Traffic is presently moving from LHS cross-road to RHS cross-road in the staggered junction on undivided carriageway cutting across the high speed traffic on the main highway.
Proposed remedial measures to the safety concerns on stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa
Similar to Junction-1, 4-lane divided carriageway has been provided near Junction-2 with right turn storage lanes. Object markers, Chevron markings, Turning arrows are all provided similar to Junction-2. Median islands, turning lanes etc., have been provided at the cross roads of Junction-2 similar to Junction-1. Stop Line and Stop Sign have been provided at the other minor cross roads joining the NH. Pedestrian footpath-cum-drains have been provided for effective drainage up to the outfall point. Cautionary signs of 'Cross roads ahead', 'Median opening ahead' etc., have been provided at appropriate locations to warn the road users ahead of the cross-road junctions.
Existing road environment of stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa
The carriageway width is increasing in this stretch from 9m to 20m with sharp curves in between. There is no central dividing median. No lane markings/signs. There is upward gradient towards Cortalim.
Proposed remedial measures to the safety concerns on stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa.
Main NH i.e., Panjim-Cortalim Road has very heavy traffic with large component of Bus traffic. Traffic from Santa Cruz side to Dental College side or to Cortalim side used to move on Santa Cruz road under two way traffic conditions, crossing the traffic streams on both carriageways of main NH making staggering maneuvers as the two way carriageway is converted to one way at Junction-4. This was causing severe conflicts. Therefore, two lane Santa Cruz road from Junction-4 to Junction-3 has been made one way road with an extra right turning lane at Junction-3. All the traffic from Santa Cruz side/Goa University side going to Panjim / Dental College complex/Cortalim were made to join main NH in one way traffic condition. Out of this traffic, those going to Dental College / Cortalim / Medical College were made to take a 'U' turn at 'U turn-1'in one way traffic condition thereby eliminating conflicting movements.
Proposed remedial measures to the safety concerns on stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa

'U turn-1 is provided on an elevated box structure and the LHS carriageway of Panjim leg is taken below the 'U' turn structure. Traffic moving towards Panjim has to move towards left two lanes outside the 'U' turn structure. This has been guided through turning arrows. Similarly, at Junction-3 traffic moving towards Santa Cruz from Goa University /Medical College side has to move towards left lanes as the Santa Cruz road is becoming two-way traffic zone beyond Junction-3 towards Santa Cruz direction. This is also facilitated through turning arrow markings. NH carriageway between Junction-4 and Junction-3 has been widened to 4-lane on RHS and 4-lane on LHS providing two lanes for straight traffic and two lanes for 'U' turning traffic. These are indicated to road users through turning arrows. After Santa Cruz road joins main NH, the carriageway towards Panjim is reduced on RHS from 4-lane to 3-lane due to space constraints.
Proposed remedial measures to the safety concerns on stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa Contd..

The carriageway has again been widened to 4-lane before 'U' turning structure providing two lanes for straight movement towards Panjim and two lanes for 'U' turning towards Dental College/ Medical College / Cortalim. As there are short weaving lengths before 'U' turning structure, speeds have been reduced using bar code type pavement markings. As there is severe restriction of radius (10 m radius) for 'U' turning on the structure, speeds were reduced to 10kmph using rumble strips and speed limit boards. Speed limits of 30 Kmph were provided outside 'U' turn to make all the maneuvers safe. Object Hazard markers were provided at Traffic island tips, R.E. wall ends etc, to caution the road users about the possible hazard. As the traffic heading towards Cortalim, Dental College and Medical College from Santa Cruz side have to be instructed to take 'U' turn on the structure by moving towards right lanes, they were guided at a sufficient advance location through turning arrows and properly designed advance direction sign.
Existing road environment of stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa
The main carriageway of the NH has width varying from 10m to 20m. There is a road connecting Santa Cruz to Goa Medical College Complex on RHS running parallel to main NH. This Santa Cruz Road has 7m undivided carriageway. This road is connected to main NH at several locations with large connecting paved areas without any channelization. This road has two way traffic movement with huge traffic turning towards Goa Medical College complex & Goa University on RHS and also towards Dental College complex on LHS cutting across high speed traffic on NH-17 (New NH-66). Traffic from Santa Cruz side to Panjim side is taking almost a 'U' turn on main NH leading to severe unsafe conditions. Lack of traffic segregation and road signs/ markings are further compounding the safety concerns. As there are no speed reduction measures, higher speeds are increasing the severity of conflicts.
Proposed remedial measures to the safety concerns on stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa
Proposed remedial measures to the safety concerns on stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa Contd..

As the traffic from Santa Cruz side to different destinations like Dental College/ Cortalim were crossing high speed NH traffic streams through un-regulated & un-channelized paved areas posing severe safety concerns, this traffic has been made to join main NH through left turn in one way traffic condition. This traffic after joining NH was made to take a 'U' turn to reach the destinations like Dental College/Cortalim as well as Goa Medical College. Out of this, the traffic destined to Panjim side would go straight, outside the 'U' turn structure and the remaining would take 'U' turn on the elevated structure. All the cross movements across main high speed NH through unregulated paved areas have been eliminated. 1.5m high pedestrian railing has been provided on the central median to prevent Jay pedestrian crossings across the high speed NH. As weaving maneuvers from right lane to left lane for Santa Cruz bound traffic were involved in short weaving length, speeds have been reduced to about 40 Kmph using rumble strips.
Proposed remedial measures to the safety concerns on stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa Contd..

Turning arrow markings have been provided to guide the road users. A triangular island Channelizer was provided at Junction-3 facilitating streamlined movement of traffic heading towards Panjim/Dental College from Santa Cruz side as well as from Cortalim side. Turning arrow markings are provided to guide the vehicles at Junction-3. Carefully designed advance direction signs aligned with road alignments have been provided to effectively guide the Road users to take their appropriate lane as per their respective destinations. In the existing condition, traffic from Goa University (VIP road) was taking left turn and joining the main NH or was crossing NH to reach Dental College/Cortalim through un-channelized paved areas. This was causing severe accidents. Therefore, left turning from Goa University Road has been closed. Entire traffic from Goa University side has been diverted through properly designed turning lanes at Goa Medical College.
Proposed remedial measures to the safety concerns on stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa Contd..

All the traffic from Santa Cruz side has been made to take left turn through repeated “compulsory left turn” sign. Cross roads joining NH on LHS were provided with cautionary “cross road” ahead sign along with rumble strips with a 40 Kmph speed limit. Traffic on LHS carriageway destined to Panjim side /Santa Cruz side have to take a 'U' turn at 'U turn-2” facility. This has been made clear to road users through properly designed advance direction signs & turning arrow markings. As weaving is involved in changing lanes from left to right for 'U' turning traffic, speeds have been limited to 40 Kmph. Due to space restrictions “U turn-2” has been provided with 7.0m radius and as such cannot accommodate turning of commercial vehicles. Therefore, height limit sign and height limit cross bar have been provided at appropriate locations. At “U-turn-2”, crash barrier has been provided to prevent vehicles / pedestrians crossing the NH avoiding use of “U” turn facility.
Existing road environment of stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa
Traffic movements on the existing highway are highly irregular and conflicting causing serious safety concerns. Central dividing median of the main NH is also not aligned in different sections and the traffic movements are involving sudden directional changes. Traffic from Goa University road towards Dental College involves movement through un-channelized unregulated junction area cutting across two way streams of the main NH. The road leading to Goa Medical College entrance is two way road without any dividing island & channelizing islands. Presence of bus parking & temple are adding to pedestrian conflicts. Large pedestrian movement is taking place from Goa Medical College on RHS to Dental College complex on LHS cutting across several one way/ two way traffic streams. There are no signs, markings and channelization. Large unpaved surfaces between different carriageways are acting as dividing islands without any drainage facilities. There are footpaths along the highway for pedestrians.
Proposed remedial measures to the safety concerns on stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa
Proposed remedial measures to the safety concerns on stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa Contd..

As Traffic from Goa University side (VIP Road) is presently taking a left turn to join Main NH and is crossing the main NH to reach Dental College/Cortalim side. This is causing serious safety concerns. Therefore, left turn from Goa University Road has been closed. Entire traffic from Goa University side has been made to join main NH through two separate 2-lane and 3-lane turning connector roads, one for the traffic destined to Panjim side /Santa Cruz side moving outside the U-turn facility and the other for the traffic entering U-turn facility to reach Dental College complex/Cortalim. Traffic joining the NH for destinations of Panjim side/Santa Cruz side should take a compulsory left turn and should not take a right turn at the NH which would cause a head on collision with traffic coming from Cortalim side on RHS carriageway.
Therefore, a “No Right Turn” sign has been provided for this traffic. Traffic coming from Goa University side has been guided through two advance direction signs properly designed and strategically located indicating the road to be taken by Panaji / Santa Cruz bound traffic and Dental College/Bambolim Stadium /Cortalim bound traffic, by aligning the directions on sign boards parallel to the directions of alignment of the road. The 3-lane road form main NH towards Goa Medical College has been made one way carrying traffic towards In-Gate of Medical College and also the traffic towards Goa University side. This has been reinforced through arrow markings on the pavement as well as one way sign. Traffic coming from Cortalim side has been guided through a over-head sign towards Goa University bound connector road, towards Panaji/Santa Cruz in the straight ahead direction and Dental College/ Bambolim Stadium/ Cortalim side towards U-turn bound right lanes.
Proposed remedial measures to the safety concerns on stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa
Contd..

An advance direction sign for Junction-5 has also been provided on the Channelizer island repeating the directions given on the over-head sign. For the traffic from Cortalim side, a properly designed Advance direction sign has been provided giving directions towards all major destinations. As the traffic from Cortalim side is approaching the Complex Junction-5 speeds have been reduced to 40 kmph using rumble strips. Turning arrow markings on each of the lanes are provided reinforcing the directions given in Informatory signs. Bus shelter and Bus Parking areas have been provided carving out space from the excess area between different connector roads and GMC compound. An additional In-gate has been provided for Medical College for smooth entry from the Goa University side. One way and two way Hazard Markers are provided at the tips of traffic islands to caution the road users.
A “No Left Turn” sign is provided to avoid traffic from Cortalim side taking a left turn towards Medical College in violation of one way. As there is large pedestrian movement across the NH from Medical College Complex to Dental College complex and vice -versa a foot over bridge with escalator has been provided near out gate of the Goa Medical College. Zebra crossings with stop lines have been provided across Goa University road for minor pedestrian movements. Traffic from Cortalim side destined to Dental College/Bambolim Stadium have to take U turn at U-turn-3. As the radius of 10.2m could be provided at this U-turn commercial vehicles except long trailers can use the U turn facility. Rumble strips have been provided in all U turns restricting the speeds to 10 kmph. Traffic from Panjim side to Goa University side /Goa Medical College has to take U turn at U turn-4. Similarly, commercial vehicles from Panjim side to Santa Cruz side have to take U turn at U turn-4 facility.
Proposed remedial measures to the safety concerns on stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa Contd..

On tangent section of LHS carriageway speeds have been reduced through bar code markings and were restricted to 40 kmph due to complex nature of this junction. All the advance direction informatory signs have been reinforced through turning arrow markings on pavement. Pedestrian footpath-cum-drains have been continued all along, providing safe walking area and crossing facility with pedestrian railings including FOB with escalator.
Existing road environment of stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa
Existing NH has carriageway width varying from 7m to 11m on each side with open space of 10m to 20m acting as a median. There are no railings, crash barriers etc. There is a parallel road to NH of about 6m carriageway width connecting pedestrian subway to the cross road leading to Cujira School complex on LHS. This parallel road and other carriageways of main NH are connected through large paved areas / cross connections of varying width without any medians / Channelizers. Minor cross roads are also joining at two locations on LHS and two locations on RHS without proper junctions. There is Bambolim stadium on LHS and GMC Quarters/GMC Pediatric Hospital on RHS. Vehicles are entering and crossing the NH carriageway at different points through un-regulated & un-channelized junctions.
Existing road environment of stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa Contd..

This area has pedestrian activity without any pedestrian facilities thereby forcing pedestrians to use the main carriageway. There are no road signs/markings. Frequent crossing of NH cutting across high speed NH traffic is causing severe conflicts. Though there is a pedestrian subway at km 4.53, pedestrians are not using it as this is located quite away from the desired pedestrian crossing point. In fact pedestrian subway is being used only by two-wheelers as this has a width of 6m. There is a Bus Stop without any bus shelter on RHS. Though the stretch is having pedestrian activity and large cross traffic movements, there are no speed regulation measures to control the high speeds on NH carriageway.
Proposed remedial measures to the safety concerns on stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa
Proposed remedial measures to the safety concerns on stretch from Km 1+980 to Km 5+190 on NH-17 in State of Goa Contd..

Traffic from Cortalim side on RHS carriageway has to take U turn at U-Turn-5 facility for Bambolim Stadium and further destinations towards Cortalim. Cross road towards Cujira School complex has been channelized and provided with Stop Sign, Stop Line markings etc. Traffic from Bambolim Stadium/School complex etc., has to take U turn at U-turn-6 facility to reach Panjim/Goa University/Goa Medical College. On footpath, a pedestrian guard rail of 1.2m height and on the central median a railing of 1.5 m height has been provided to restrict the pedestrian crossings only to the designated pedestrian crossing facilities, avoiding Jay crossing of pedestrians across high speed NH. Pedestrian footpath of 2m width has been provided to facilitate utilities like street light posts. Lighting has been provided all along the stretch to keep the complex junction areas well lit. At 5 locations in the complex junction area high mast lights have been provided for good night visibility.
Thank You