Traffic Impact Study and Signal Design at Suchitra Junction, Qutubullapur, Rangareddy, Telangana, India

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Abstract: *TIS (Traffic impact study) is generally required to support the transportation aspects of a proposed development that has the potential to generate significant amounts of pedestrians, bicycle trips, transit users and vehicular traffic. Traffic rules and regulations are devised to assure the smooth flowing of motor vehicles in the road. Moreover, traffic rules and regulation are not only for the driver of the vehicles but at the same times these rules are meant for the pedestrians, cyclist, motor-cyclist and other road users. Traffic signal is an aid to control traffic at intersections where other control measures fail. The signals operate by providing right of way to a certain set of movements in a cyclic order. The necessary data should be collected by means of traffic engineering studies. Minimum vehicular volume, interruption of continuous traffic, minimum pedestrian volume, accident experience, combination of above warrants. Combination of warrants when no single warrant is satisfied but indicating two or more warrants of above are satisfied to the extent of 80 percent or more of the stated volume. Traffic control signal shall be installed at Suchitra junction for the following signal warrants meeting. As the average traffic flow for 8 hours on both approaches exceeding 800 vehicles. Interruption of continuous traffic flow on the major street exceeding 1000 vehicles per hour. As 150 or more pedestrians per hour crossing a major street with over 600 vehicles per hour on both approaches.*

Keywords: Literature review, study area, traffic impact study, methodology, traffic signals

1. Introduction

Traffic Impact Study (TIS) is a systematic and scientific study to analyze the impact of the traffic generated by a new development on the surrounding transportation system. A TIS is generally required to support the transportation aspects of a proposed development that has the potential to generate significant amounts of pedestrians, bicycle trips, transit users and vehicular traffic. A well-prepared traffic impact study helps the developer and permitting agency accomplish the following:

- Forecast the traffic impacts created by proposed development based on accepted practices, not perceptions.
- Determine improvements needed to accommodate the proposed development.
- Allocate funds more efficiently.
- Evaluate more number, location, and design of access points.
- Update traffic data.
- Identify needed roadway improvements.
- Provide a basis for determining the developer's responsibility for specific off-site improvements.

2. Study Area

Suchitra Junction or Suchitra Center Suchitra cross roads is one of the fastest growing suburbs of Hyderabad, India. It has become a hub on Bowenpally-Medchal Road. The western road leads to Chintal, Shahpur, Jeedimetla, IDPL. The eastern road leads to Alwal via Loyola College. Suchitra is witnessing traffic issues during rush hours.

Traffic impact studies help communities to

- Forecast additional traffic associated with new development, based on practices.
- Determine the improvements that are necessary to accommodate the new development.
- Assist communities in land use decision making.
- Assist in allocating scarce resources to areas which need improvements.
- Identify potential problems with the proposed development which may influence the developer's decision to pursue it.
- Allow the community to assess the impacts that a proposed development may have.
- Help to ensure safe and reasonable traffic conditions on streets after development is complete.
- Reduce the negative impacts created by developments by helping to ensure that the transportation network can accommodate the development.
- Provide decision to community decision makers and developers of expected impacts.
- Protect the substantial community investment in the street system.
- Traffic impact studies should be used as one piece of several kinds of information to judge the suitability of development from a transportation stand point.

Satellite View of Suchitra Junction
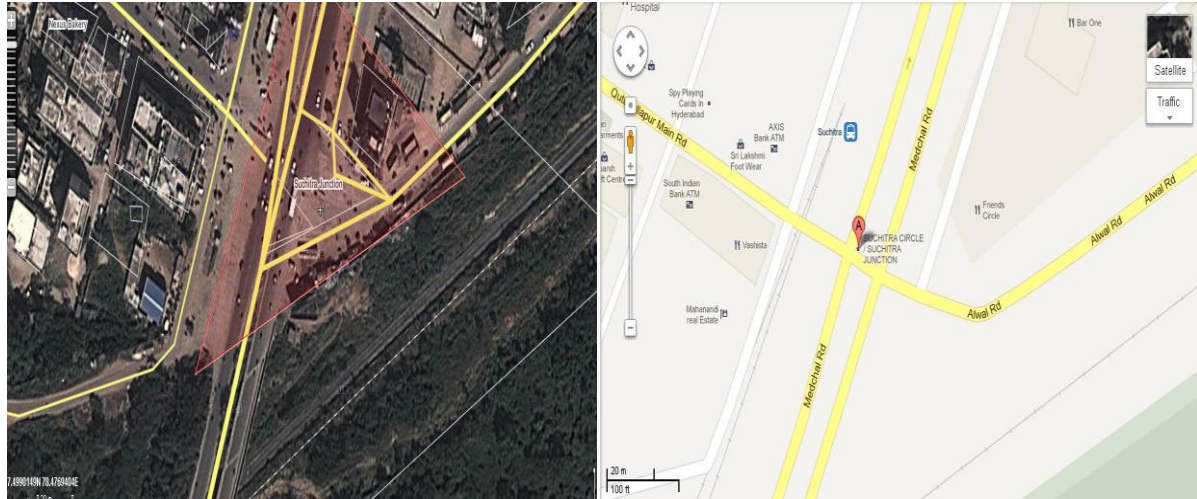
Land Use	Typical Peak Hours
Residential	7:00-9:00 am weekday and 4:00-6:00 pm weekday
Regional shopping centre	2:30-3:30 pm weekends 5:00-6:00 pm weekdays
Office	7:00-9:00 am weekday 4:00-6:00 pm weekday

3. Literature Review

L.R Kadiyali[2] Said that a number of definitions and notations need to be understood in signal design. They are discussed below:

1) Cycle: A signal cycle is one complete rotation through all of the indications provided.
2) Cycle length: Cycle length is the time in seconds that it takes a signal to complete one full cycle of indications. It indicates the time interval between the starting of green for one approach till the next time the green starts. It is denoted by C.
3) Interval: Thus it indicates the change from one stage to another.
4) Green interval: It is the green indication for a particular movement or set of movements and is denoted by "Gi". This is the actual duration the green light of a traffic signal is turned on.
5) Red interval: It is the red indication for a particular movement denoted by "Ri".
6) Phase: A phase is the green interval plus the change and clearance intervals that follow it. Thus, during green interval, non conflicting movements are assigned into each phase. It allows a set of movements to flow and safely halt the flow before the phase of another set of movements start.
7) Lost time: It indicates the time during which the intersection is not effectively utilized for any movement.

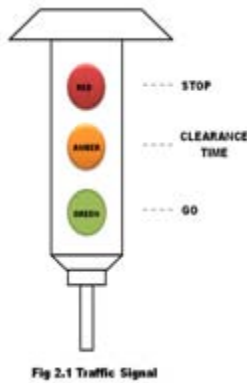### Slater R.J[4] said about traffic signal signs

(1)Circular green alone: Vehicular traffic facing a green signal may proceed straight through or turn right or left unless a sign or marking at such place prohibits either such turn or straight through movement, except that such traffic shall yield the right of-way to pedestrians and vehicles lawfully within a crosswalk or the intersection at the time such signal was exhibited; pedestrians facing the green signal, except when directed by separate pedestrian-control signals, may proceed across the highway within any marked or unmarked crosswalk.

(2) Yellow: Vehicular traffic facing a steady yellow signal is thereby warned that the related green movement is being terminated or that a red indication will be exhibited immediately thereafter, when vehicular traffic shall stop before entering the intersection unless so close to the intersection that a stop cannot be made in safety ;pedestrians facing a steady yellow signal, except when directed by separate pedestrian-control signals, are thereby advised that there is insufficient time to cross the roadway before a red indication is shown and no pedestrian shall then start to cross the roadway.

(3) Red alone: Vehicular traffic facing a steady red signal alone shall stop before entering the crosswalk on the near side of the intersection or, if none, then before entering the intersection and remain standing until the next indication ; provided, on or after July 1, 1979, vehicular traffic traveling in the travel lane nearest the right hand curb or other defined edge of the roadway, unless a sign has been erected in the appropriate place prohibiting this movement, may cautiously enter the intersection to make a right turn onto a two-way street or onto another one-way street on which all the traffic is moving to such vehicle's right after such vehicle has stopped as required in this subdivision and yielded the right-of-way to pedestrians lawfully within an adjacent crosswalk and to other traffic lawfully using the intersection..

(4) Green arrow: Vehicular traffic facing a green arrow signal, shown alone or in combination with another indication, may cautiously enter the intersection only to make the movement indicated by such arrow, or such other movement as is permitted by other indications shown at the same time, but such vehicular traffic shall yield the right-of-way to pedestrians lawfully within a crosswalk and to other traffic lawfully within the intersection.

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Fig 2.1 Traffic Signal

Rao G.V[5] said that traffic signals control vehicle and pedestrian traffic by assigning priorities to various traffic movements to influence traffic flow. Properly designed, located and maintained traffic signals have one or more of these advantages:
• Provide for orderly movement of traffic;
• Increase traffic-handling capacity of an intersection;
• Reduce frequency and severity of certain types of crashes, especially right-angle collisions;

4. Methodology

To approximate design procedures and one rational approach (Webster's method) for the design of traffic signal cycles are given below for fixed time traffic signals at cross roads. In addition the signal design method as per the guidelines of the IRC is also given. For the purpose of simplicity, two phase traffic signals with no turning movements are illustrated here. The methods may be suitably extended for multi phase operation.

Trial Cycle Method: The 15 minute-traffic counts n_1 and n_2 on roads 1 and 2 are noted during the design peak hour flow. Some suitable trial cycle C_1 second is assumed and the number of the assumed cycles in the 15 minutes or 10 x 60 seconds period is found to be (15 x 60)/C_1, i.e. (900/C_1). Assuming average time headway 2.5 seconds, the green

periods G_1 and G_2 of roads 1 and 2 are calculated to clear the traffic during the trial cycle.

$$G_1 = 2.5 n_1 C_1 / 900 \text{ and } G_2 = 2.5 n_2 C_2 / 900$$

The amber periods A_1 and A_2 are either calculated or assumed suitably (3 to 4 seconds) and the cycle length C_1' is calculated, equal to $(G_1 + G_2 + A_1 + A_2)$ seconds. If the calculated cycle length C_1' works out to be approximately equal to the assumed cycle length C_1, the cycle length is accepted as the design cycle. Otherwise the trial cycles are repeated till the trial cycle length works out approximately equal to the calculated value.

Webster's Method: The optimum signal cycle is given by:
$C_0 = 1.5L + 5/1 - Y$
Where L = total lost time per cycle, seconds = 2n + R (n is the number of phase and R is all red-time)
$$Y = y_1 + y_2$$
Then, $G_1 = y_1/Y(C_0 - L)$ and $G_2 = y_2/Y(C_0 - L)$
Similar procedure is followed when there is more number of signal phases.

Analysis and Discussions of Traffic Impact Study
For the traffic impact study, a four legged intersection is chosen at Suchitra in Hyderabad and conducted a traffic volume count. Here the observation shows the capacity of dual lane carriageway with one direction exceeds by volume travels at the junction. To measure the traffic volume counts manual method of count was adopted.
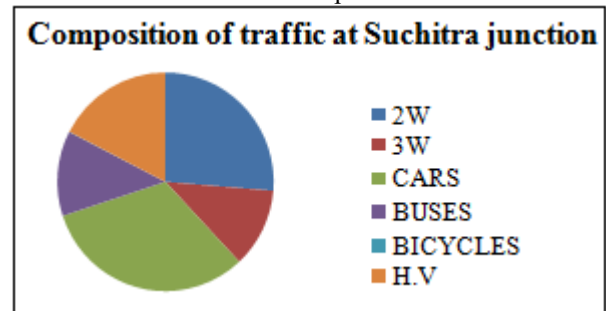
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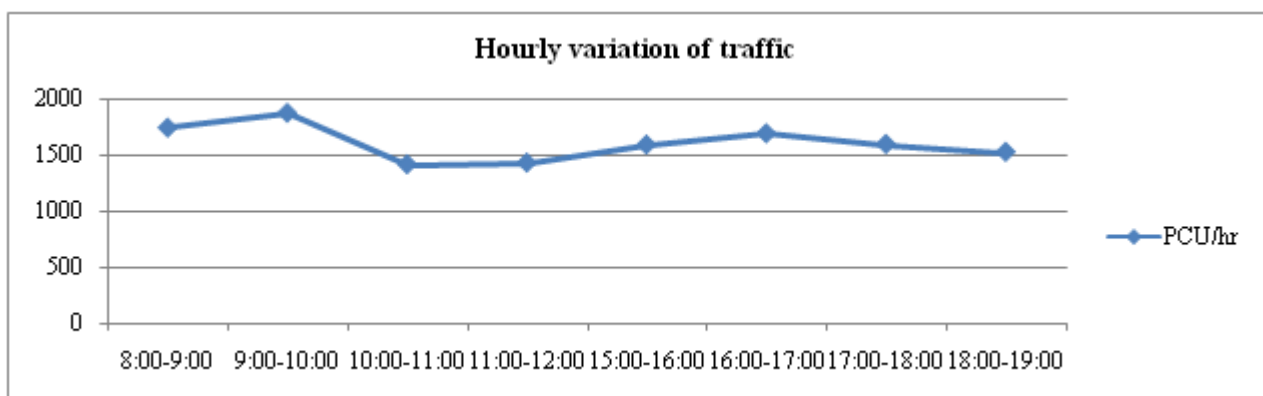
Hourly peak traffic (Time versus Hourly traffic)

5. Results

To install signals at an intersection at least one warrant as mentioned in the earlier chapters should be satisfied. For the present study the design hourly volume is more than the

motor vehicles per hour. So there is a need to establish traffic signal at the Suchitra junction
Design traffic volume on Leg1=2044 PCU/hr
Design traffic volume on Leg2=1062 PCU/hr
Design traffic volume on Leg3=787 PCU/hr

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Design traffic volume on Leg4=2022 PCU/hr
Approach volume per lane on leg1:n_1=2044/2=1022pcu/hr
Approach volume per lane on leg2:n_2=1062/2=531pcu/hr
Approach volume per lane on leg3:n_3=787/2=393pcu/hr
Approach volume per lane on leg4:n_4=2022/2=1011pcu/hr

1. Pedestrian green time for Leg1=18/1.2+7.0= 22.0 sec
   Pedestrian green time for Leg2=13.8/1.2+7.0= 18.0 sec
   Pedestrian green time for Leg3=14/1.2+7.0= 19.0 sec
   Pedestrian green time for Leg4=20.5/1.2+7.0= 24.0 sec
2. Green time for vehicles on Leg2, G_2=25.0sec
3. Green time for Leg1, G_1=25.0*(1022/531)=48.0 sec
   Green time for Leg3, G_3=25.0*(704/794)=10.0 sec
   Green time for Leg4, G4=25.0*(1011/1022)=25.0 sec
4. Adding 3.0secs each towards clearance amber and 4.0 sec.
5. Inter-Green period for each phase,
6. Total cycle time required
   =(3+48+4)+(3+25+4)+(3+10+4)+(3+25+4)=136.0 sec
7. The extra 3.5secs per cycle may be apportioned to the green times of Leg1,Leg2,Leg3,Leg4 as 1.0,1.0,1.0and 1.0sec and so
   G_1=48+1=49.00sec
   G_2=25.00+1.00=26.00sec
   G_3=10.00+1.00=11.00sec
   G_4=25.00+1.00=26.00sec
8. Vehicles arrivals per lane cycle on Leg1=1022/136=8.0 PCU
   Minimum green time for clearing vehicles on Leg1=6+ (8.0-1.0)*2 =20.00 sec
   Vehicles arrivals per lane cycle on Leg2=531/136=4.0 PCU
   Minimum green time for clearing vehicles on Leg2=6+ (4.0-1.0)*2 =12.00 sec
   Vehicles arrivals per lane cycle on Leg3=393/136=3.0 PCU
   Minimum green time for clearing vehicles on Leg3=6+ (3.0-1.0)*2 =10.00 sec
   Vehicles arrivals per lane cycle on Leg4=1011/136=7.4 PCU

Minimum green time for clearing vehicles on Leg4=6 + (7.4-1)*2 =19.00 sec
As the green time provided for the four legs by pedestrian crossing criteria in (iii) above are higher than these values, the above design values are all right.

9. Lost time per cycle L=n(I-a)+n*l =4(4-3) +4*2=12.0 sec
   Where, Amber time, a=3sec.
   Last time due to starting delays, l=2sec.per phase
   No. of phases, n=4
   Inter green period, I=4.0sec
   Saturation flow for Leg1=525*9.0=4725 PCU/hr
   Saturation flow for Leg2=525*6.9=3622 PCU/hr
   Saturation flow for Leg3=525*7.0=3675 PCU/hr
   Saturation flow for Leg4=525*10.5=5512.5 PCU/hr
   Normal flow on Leg1=y_1=1022/4725=0.21
   Normal flow on Leg2=y_2=531/3622=0.14
   Normal flow on Leg3=y_3=393/3675=0.10
   Normal flow on Leg4=y_4=1011/5512.5=0.18
   Total Normal flow Y=y_1+y_2+y_3 +y_4
    =0.33+0.21+0.23=0.65
   Optimum cycle time (C_O) =1.5L+5/1-Y
    =1.5*12+5/1-0.65=66.00sec
   Therefore the cycle time of 136 sec
   The effective green time =136-12=124 sec.
   The effective green time for phase1; G_1 =y_1/Y*(EGT)
    = (0.21/0.66)*124.0 =39.45 sec
   Actual green time =G_1+l-a=39.45+2-3=38.45~38 sec
   The effective green time for phase2; G_2 =y_2/Y*(EGT)
    = (0.14/0.65)*124.0=26.7 sec
   Actual green time =G_2+l-a=26.7+2-3=25.7~26 sec
   The effective green time for phase3; G_3 =y_3/Y*(EGT) = (0.10/0.65)*124.0=19.07sec
   Actual green time =G_3+l-a=19.07+2-3=18.07~18sec
   The effective green time for phase4; G_4 =y_4/Y*(EGT)= (0.18/0.65)*124.0 =34.3 sec
   Actual green time =G_4+l-a=34.3+2-3=33.3~33.0
   The total optimum cycle time required is 136.00secs.

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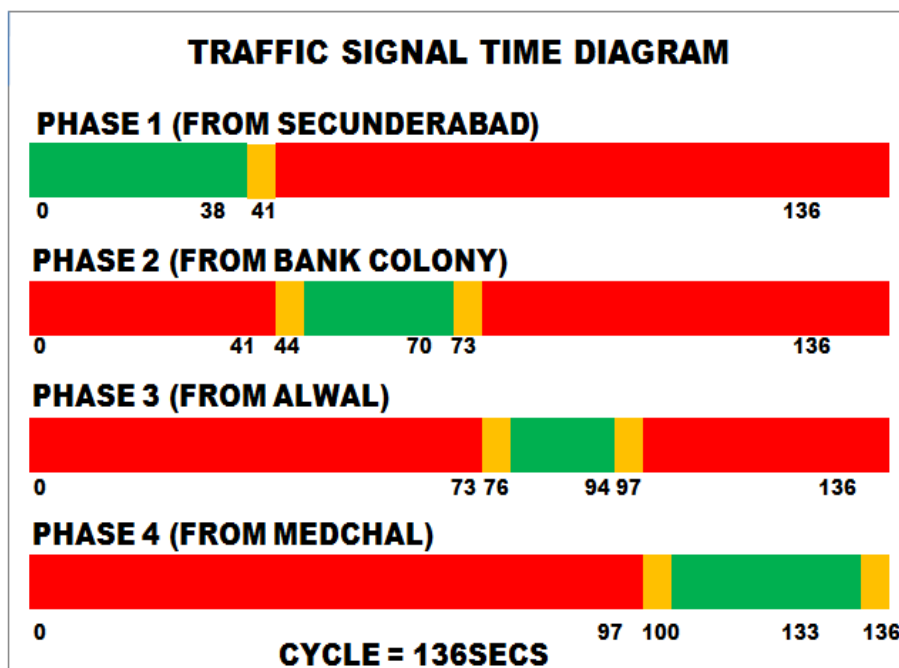
The layout of the junction with total volume and design hourly volume is pictorially   represented. The design calculations are presented in this chapter. The signal timings are shown in the form of Time Diagrams.

6. Conclusions

Traffic control signal shall be installed at Suchitra junction for the following signal warrants meeting.
- As the average traffic flow for 8hours on both approaches exceeding 800 vehicles.
- Interruption of continuous traffic flow on the major street exceeding 1000 vehicles per hour.
- As 150 or more pedestrians per hour crossing a major street with over 600 vehicles per hour on both approaches.

The following information is concluded from our design.
- Total cycle time required in seconds= 136.00
- Optimum cycle time in seconds= 66.00
- Actual green time for phase 1= 38.00
- Actual green time for phase 2= 26.00
- Actual green time for phase 3= 18.00
- Actual green time for phase 4= 33.00

References

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