



# SATURATION FLOW AND ITS ANALYSIS AT SIGNALIZED INTERSECTIONS IN URBAN AREA

P.Parameswara Rao<sup>\*1</sup>, Kasireddy.Prathap Reddy<sup>\*2</sup>

<sup>\*1</sup> Pursuing M.Tech (Transportation Engineering),

<sup>\*2</sup> Working as Assistant Professor, Samskruti college of Engineering & Technology,  
kondapur Village, Ghatkesar, RangaReddy District, Telangana, (India)

## ABSTRACT

This project deals with the saturation flow and its analysis at signalized intersections in urban areas. At-grade intersections stand out amongst the most essential components that control the execution of street organization. For productive and safe development lion's share of the convergences are signalized and extensive volumes of movement on city street organization. The limit, the plan and operation of a signalized intersection basically rely upon passenger car unit (PCU) and saturation flow. Operation and Performance of signalized crossing points is affected by the working parameters, activity condition, roadway parameters and natural conditions alongside users behavioral attributes which essentially vary among areas. The intersections on urban roads in India take into account heterogeneous mechanized activity alongside moderate moving movement including people on foot. Therefore, it is necessary to consider saturation flow for mixed traffic conditions and passenger car unit (PCU) to evaluate the overall operation of signalized intersections.

**Keywords :** Passenger Car Unit (PCU), Signalized Intersection, Saturation Flow and Mixed Traffic.

## I. INTRODUCTION

India could be a creating nation and its urban areas are experiencing quick urbanization and modernization accordingly there is increment in the street movement development. Activity development in Bharat is horrendously exceptional because of the heterogeneous movement stream having a similar carriage way. Moreover regardless of having path markings, the greater part of the circumstances path train is not taken after especially at crossing points.

Interstate ability manual and different works expect homogeneous and path principally based activity for examination, which exists in created nations. There is remarkable sidelong development at crossing points and vehicles tend to utilize horizontal holes to achieve the leader of the line and surpass even all through immersed half of unpracticed part. Because of these basic varieties, the standard western connections for foreseeing the estimations of immersion streams and PCU factors aren't relevant for creating nations like INDIA. For rectify these parameters should be measurable essentially in light of the local winning movement conditions and thus requires a totally extraordinary approach of examination. The saturation flow rate will be computed to the cheap accuracy, the capability of the signalized intersection will be evaluated.

### 1.1 Intersection:

Intersection (convergence) is a region shared by two or additional roads. This space is decided for the vehicles to show to entirely unexpected bearings to accomplish their coveted goals. Its primary work is to control vehicles to

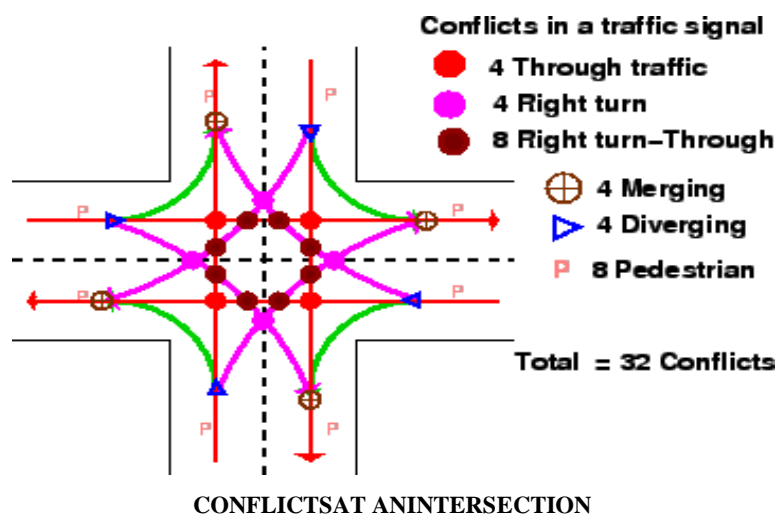
their individual bearings. Movement crossing points square measure propelled areas on any street. This is regularly because of vehicles occupation entirely unexpected bearing wan to involve same region at a comparable time. Also, the people on foot conjointly get same region for intersection. Drivers need to manufacture squint of call at a crossing point by considering his course, convergence unadulterated arithmetic, speed and heading of option vehicles and so on. A little mistake in judgment will cause extreme mischances. It conjointly causes deferral and it relies upon kind, geometry, and kind of administration. General activity stream relies upon the execution of the crossing points.It conjointly influences the capacity of the street or road. In this manner, each frame the mishap point of view and in this way the limit viewpoint, the investigation of crossing points imperative for the movement designs especially inside the instance of urban circumstance.

**1.2. Conflicts At Associate Degree Intersection**

Conflictsatassociatedegreeintersectionsquaremeasuretotallydifferentforvarious kindsof convergence (intersection). Consider a run of the mill four-legged convergence as appeared in figure. The amount of contentions for contender through developments square measure four, where as contender right flip and through developments square measure eight. The contentions between right flip traffics square measure four, and between left flip and blending activity is four. The contentions made by people on foot are eight thinking about all the four methodologies. Wandering activity conjointly creates concerning four clashes. In this manner, a run of the mill four leg like crossing point has concerning 32 distinct sorts of contentions. This is frequently appeared in fig. The pith of the crossing point administration is to determine these contentions at the convergence for the sheltered and efficient development of each activity and walkers. Two methodologies of convergence controls square measure there: sharing and zone sharing. The kind of crossing point administration that must be received relies upon the activity volume, esteem concerned, street geometry, significance of the street and so on.

**1.3. Levels of the intersection management**

The administration of partner degree crossing point might be practiced at very surprising levels. They'll be either uninvolved administration, dynamic administration or semi control. In inactive administration, there's no express administration on the main impetus. In semi administration, some measure of administration on the main thrust is there from the activity organization. Dynamic administration implies that the development of the activity is completely controlled by the movement organization and in this manner the drivers can't just move the convergence as per his decision.

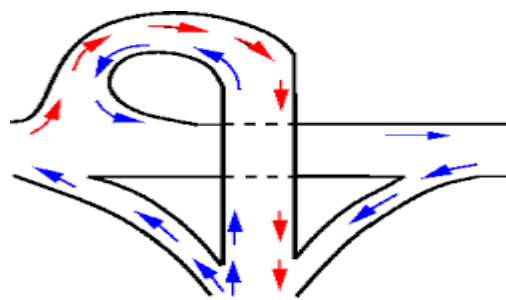


As we have a tendency to specified before, review isolated crossing points are given to isolate the movement inside the vertical review. Be that as it may, the movement needn't be those bearing on street exclusively. Once a railroad line crosses a street, at that point likewise level separators are utilized. Varying sorts of review separators are flyovers and exchange. Flyovers itself are subdivided into scaffold and metro. When two streets cross at some degree, if the street having real activity is raised to a superior level for any development of movement, at that point such structures are alluded to as extension. Something else, if the key street is discouraged to a lower level to cross partner other by implies that of a beneath scaffold or passage, it is called under-pass. Interchange could be a system wherever traffic between two or additional roadways flows at completely different levels within the grade separated junctions. Common forms of interchange embrace trumpet interchange, diamond interchange and cloverleaf interchange.

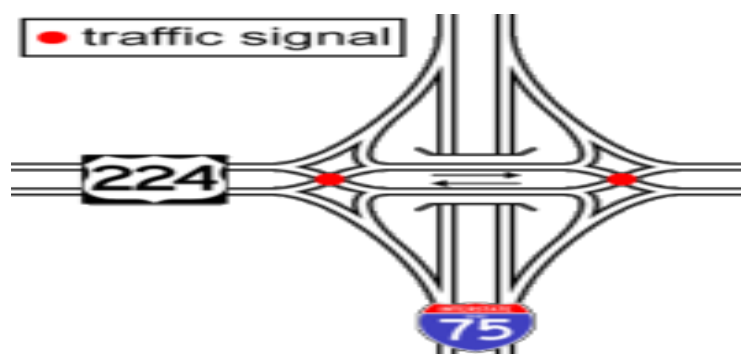
**1.Trumpet interchange:** Trumpet interchange could be a very much enjoyed kind of 3 leg trade. On the off chance that one among the legs of the trade meets a street at some point however doesn't cross it, at that point the exchange is named trumpetinterchange.

**2. Diamond interchange:** Diamond interchange could be an all around enjoyed kind of four-leg trade found inside the urban areas wherever major and minor road crosses. The essential component of this trade is that it are regularly outlined though the key road is nearly thin

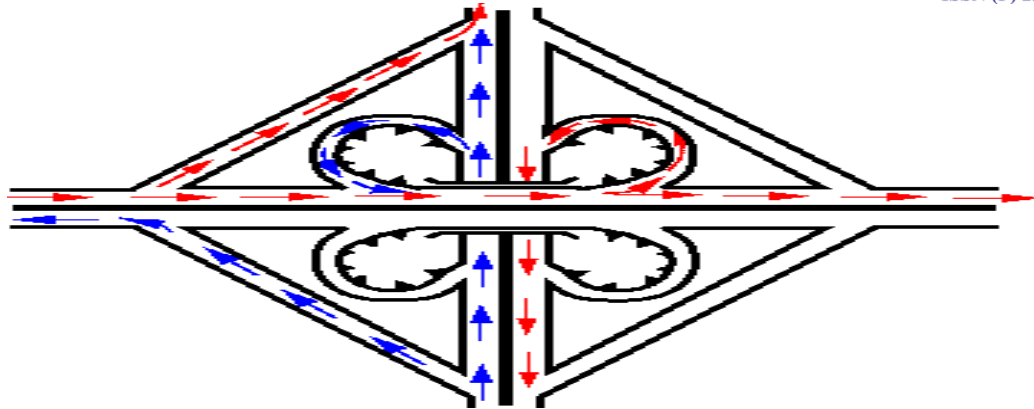
**3. Clover leaf interchange:** its furthermore a four leg trade and is utilized once two highways of high volume and speed see each other with noteworthy turning developments. The most favorable position of exchange convergence is that it gives finish detachment of activity. Furthermore, rapid at crossing points can be accomplished. Notwithstanding, the inconvenience is that tremendous space of land is required. Accordingly, cloverleaf trades are given fundamentally in provincial regions like rural areas.



TRUMPET INTERCHANGE

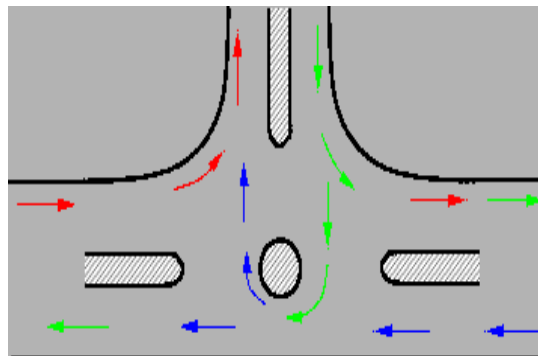


DIAMOND INTERCHANGE

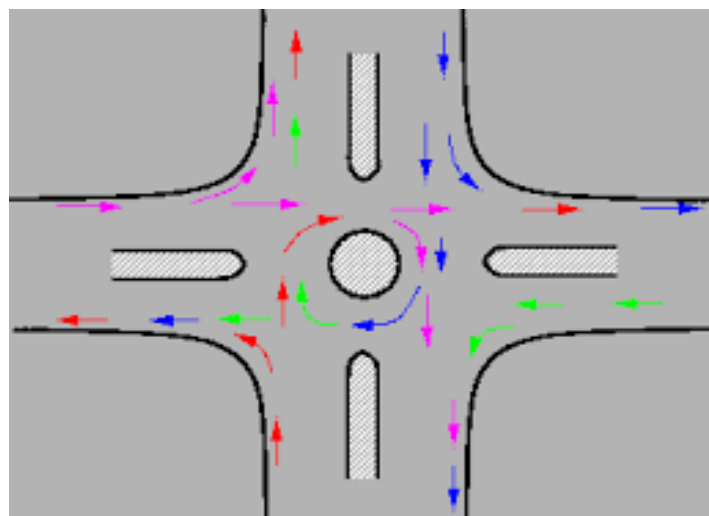


Clover Leaf interchange

**1.2 Channelized Intersection :** Vehicles moving toward relate intersection are coordinated to positive strategies by islands, checking and so forth and this philosophy of administration is named course. Channelized convergence gives a considerable measure of wellbeing and strength. It lessens the quantity of potential clashes by decreasing the domain of contentions out there inside the roadway. On the off chance that no channelizing is given the main thrust can tend to downsize the speed though getting into the crossing point from the carriage way. The nearness of movement islands, checking and so forth powers the main impetus to downsize the speed and turns out to be more careful where as manoeuvring the crossing point. A channelizing island furthermore is a shelter for people on foot and makes crossing more secure. Course of activity through a legged convergence.



Channelization of Traffic Through A Three-Legged Intersection



Channelization of Traffic Through A Four-Legged Intersection

### **2.1 Studies On Performance Analysis Of Signalized Intersections**

**2.1.1 Kara And Raheel (2000)** broke down the impacts of various light-weight duty trucks (LTDs) on the capability of signalized intersections. Multivariate investigation created assessments of types of progress identified with differed classes of LDTs also as traveler vehicles and figured railroad auto reciprocals. It had been told that the effects of LDTs were to be extraordinary idea once investigating the ability of signalized intersections.

**2.1.2 Bradon Associate Degreed Nagui (2002)** abridged the consequences of an experimental investigation of path volume data relate degreeed gave an examination of six path decision methodologies wont to evaluate path streams. The path decision ways were utilized as half of the sub aggregate approach for evaluating immersion streams. The examination showed that the decision technique upheld square with back of line or cycle normal line gives the best forecast of path volumes and these outcomes demonstrated three global ability guides exploitation relate degree break even with stream size connection or level of immersion procedure for assessing path stream might want an outsized data combination push to check the outcomes.

**2.1.3 Satish Chandra And Upendra Kumar (2003)** have arranged an idea to gauge the PCU issue for a mode in an extremely blended movement surroundings using space idea. It had been discovered that the PCU for a vehicle kind will increment directly with the measurement of roadway. This was credited to the greater flexibility of development on more extensive streets and along these lines a greater speed differential between a car and a vehicle kind. The limit of a two path street conjointly will increment with add up to measurement of the roadway and along these lines the connection between two takes after a moment degree bend and this relationship was utilized to infer the modification factors for substandard path widths

## **III. METHODOLOGY**

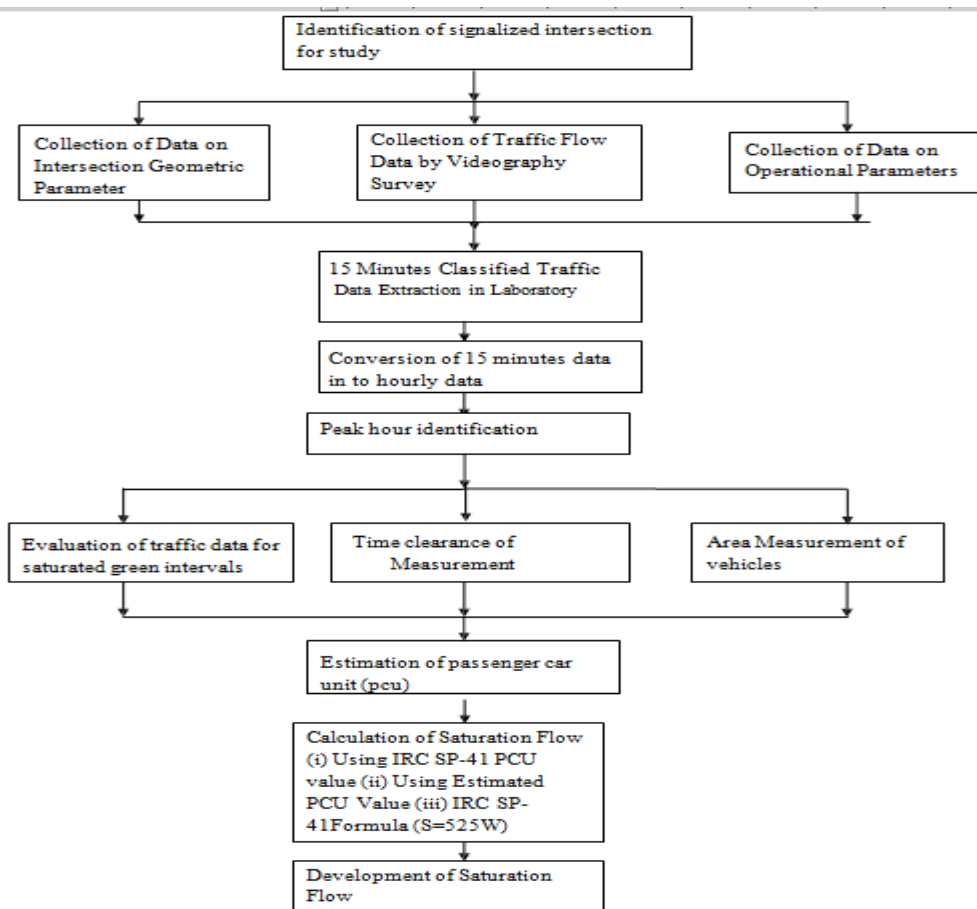
### **3.1 Geometric Design**

This part shows geometric style pointers for signalized crossing points upheld an audit of specialized writing and current style arrangement inside the utilization. Geometric style of a signalized convergence includes the handy design of travel paths, check inclines, crosswalks, bicycle paths, and travel stops in each the even and vertical measurements. Geometric style contains a significant effect on street security; it shapes street client desires and characterizes an approach through a crossing point wherever a few clashes exist. Notwithstanding security, geometric style impacts the operational execution for all street clients. Limiting impedances, taking out the need for path changes and union moves, and limiting the predefined to cross a convergence all encourage enhance the operational strength of a convergence. The requirements of all potential street clients ought to be thought of to acknowledge best security and operational levels at a crossing point. On occasion, style goals could struggle between street client gatherings; the expert individual ought to thoroughly look at the necessities of each client, set up the tradeoffs identified with all aspects of geometric style, and make determinations because of all street client groups. This tends to the ensuing subjects:

- Principles of channelization.
- Range of intersection approaches.
- Intersection angle.

- Horizontal and vertical alignment.
- Corner radius and curb ramp style
- Detectable warnings.
- Access management.
- Sight distance.
- Pedestrian facilities.
- Bicycle facilities.

The result of heterogeneousness of traffic on saturation flow and performance and capability analysis of signalized intersections. Road capability manual (or) highway capacity manual (HCM) gives premise to the capacity investigation bolstered estimation of immersion stream construct for the most part with respect to progress estimations at stop line all through soaked stream condition for perfect base states of uniform movement and path etymologizing and applying alteration elements to represent different impacting parameters. This approach is in effect wide utilized in the greater part of the created nations since it speaks to their activity conditions. Inside the blessing study attempt has been made to live immersion stream inside the field by really estimation the stream at the stop line all through soaked unpracticed part and to check the effect of different impacting parameters like movement arrangement and street widths and so on bolstered real field thinks about/tests of the standard Indian activity conditions. The orderly stream diagram of this examination work is spoken to in beneath stream graph.



Field surveys were exhausted order to gather the subsequent parameters:

- Roadway/Approach conditions and operational parameters
- Traffic conditions

As a part of route conditions information activity of all approach widths at stop line, length and widths of taper, breadth of median, breadth of left slip roads, size of channelizing, side walks etc were taken manually on site by measurement tape and measurement wheel. The amount of lanes for turning traffic in every direction viz straight through (TH) and right (RT) were additionally noted. The signal temporal order for every colony of each approach was noted manually for all the intersection. Roadway condition and operational data for various approaches for all the selected intersections are given below table

Geometrical and operational details of the intersections:

<b>INTERSECTIONS</b>	<b>TRAFFIC APPROACH FROM</b>	<b>WIDTH (M)</b>	<b>CYCLE TIME (SEC)</b>	<b>GREEN TIME (SEC)</b>	<b>AMBER TIME (SEC)</b>	<b>RED TIME (SEC)</b>
Tarnaka	Uppalringroad (NB)	10	160	45	3	120
	Habsiguda (SB)	12.5	160	45	3	120
	Lalapet (EB)	10	160	45	3	120
	Osmania university(WB)	11	160	45	3	120
Alkapuri	Nagole(NB)	14	120	60	3	100
	L.B.Nagar(SB)	14	120	60	3	100
Ecil	Kushiguda (NB)	9.4	140	60	3	140
	Moulaali(SB)	12	140	60	3	140
	Radhika (EB)	14	140	60	3	140
	NTPC(WB)	10	140	60	3	140

**NB=NORTH BOUND;SB= SOUTH BOUND;EB= EAST BOUND;WB=WEST BOUND**

Activity condition data manages the circle movement stream designs (activity volume) of different turning developments, activity organization, freedom/speed time of different vehicles at each segment of the flag at totally unique methodologies of the signalized crossing points amid this examination, activity turning development data of the subject methodologies of the crossing points was recorded by utilizing a transportable





advanced camcorder mounted on the 6m (20ft) high remain at the middle or choices island or at a perspective at the corner of the crossing point to conceal every one of the, maybe a couple or three in all the methodologies of the convergence all together that it unmistakably catch read of approach street from leave (line association closures of channelizing islands) of each the through (TH) and right (RT) developments up to in regards to 10m inside the stop line on the best approach. Persistent film of the activity stream were recorded with camcorder for crest morning measure of a few hours between 9:00 am to 12:00 evening on conventional week days. At the same time data on flag fleeting request i.e. cycle length, scope of areas and stage length was gathered physically

The recorded movies were replayed inside the lab on a larger than average screen in order to recover the predefined learning data for the investigation. Inside the underlying area 15 minute arranged activity turning development learning were recovered for whole time of review for all the methodologies to work out pinnacle hour, top issues, movement organization, crest hour activity volumes, offer of turning movement and so forth for each approach, turning development and convergence. Immersed unpracticed sum for the unpracticed time of the theme development was taken from five seconds when the beginning of the unpracticed area until the tip of dispersal of line length. With a specific end goal to recover the immersed unpracticed interims for individual unpracticed stages all through crest hour video records were replayed for individual unpracticed stages previously truly recovering the ordered development information for individual soaked unpracticed interims of flag periods of the point approaches. All through each soaked green interim of pinnacle hour freedom time of different vehicles were conjointly recovered on arbitrary specimen bases keeping in mind the end goal to evaluate PCU esteems all through immersed stream. Leeway time was taken as time of auto possessing the crossing point normal space/range from complete of edge line at section to complete of edge line at (entry of front bumper at entry line to exit of rear bumper at exit line). PCU esteems were ascertained exploitation condition created by Chandra and Kumar and exploitation these qualities immersion stream was measurable in PCU every hour for each approach. At long last, immersion stream demonstrate is produced for non-path based for the most part blended MIndian activity conditions.

#### Data Analysis:

Information investigation of fluctuated activity attributes like movement volume, activity sythesis, crest hour movement volume, peak hour issue and activity creation and so on was stuck in an unfortunate situation each turning development, each approach and crossing point as entire for each convergence. Arranged activity information for immerse unpracticed interims of the considerable number of periods of through (TH) and right turning (RT) developments were supplemental to figure the run of the mill immersion stream (number of vehicles every hour green) as there have been no isolated path for through (TH) and right turning (RT) developments of the different methodologies. PCU factors for different classes of vehicles were measurable for soaked stream condition exploitation condition created by Chandra and Kumar and exploitation. These qualities immersion stream were measurable in PCU every hour for each approach as appeared in beneath table:





<b>Approach road</b>	<b>Approach width</b>	<b>Jeeps/ cars/van/ taxi BIG AND SMALL</b>	<b>THREE WHEELERS (AUTO-RICKSHAWS)</b>	<b>TWO WHEELERS (MOTOR CYCLES/ SCOOTERS)</b>	<b>NON-MOTORIZED TRAFFIC (NMT) BICYCLES AND CYCLE RICKSHAWS</b>
Nagole(NB)	14	1.59	0.9	0.26	0.69
L.B.Nagar (SB)	14	1.49	0.9	0.28	0.83
Average	14	1.54	0.9	0.27	0.76

Saturation flow was calculated for every approach by exploitation formula given below:

$$S = (\text{total number of vehicle (PCU)} / \text{saturated green time in sec}) \times 3600$$

S= Saturation Flow in vehicle/h OR (PCU/h)

Comparison of Saturation Flow Obtained exploitation calculable PCU, IRC SP-41 PCU and IRC SP- 41Empirical Formula:

Characterized immersion stream data of all the tallness hour cycles were usual get normal immersion stream for each approach. The deliberate cost of normal Saturation Flow of different methodologies of study crossing points communicated as far as PCU every hour abuse measurable PCU esteems, IRC SP-forty one PCU esteems.

Evaluated according to condition  $S=525W$  as given by IRC SP-41as for each UK system has been presented. The normal immersion stream totally of different methodologies is found to shift at various methodologies. it's conjointly discovered that normal immersion stream got through field examines is higher in the two cases once communicated misuse field measurable PCU esteems and IRC SP-41 PCU esteems than the immersion stream got by summed up recipe  $S=525*W$  of IRC SP-41.

It is conjointly discovered that immersion stream measured inside the field abuse IRC SP-41 PCU esteems isn't reliable with the widths of methodologies. The value of immersion stream for approach broadness of 9.7 m is lower than that for 9.4 m approach expansiveness. Likewise the immersion stream for approach broadness 10.3 m and 11.7m are lower than that of approach widths of 10.0 m and 11.0 m severally and is negating. While the immersion stream got inside the field abuse evaluated PCU esteems from (field information) zone unit observed to be predictable with approach widths and ponders have an impact of modest variety in widths legitimately.

Comparison of measured saturation flow (pcu/h) of different approaches calculated using different pcu factors/ methods:



INTERSECTIONS	APPROACH NAME	WIDTH (M)	SATURATION FLOW (PCU/h)		
			Field estimated S=525xW	As per IRC SP-41	pcuas per IRC SP- 41
Tarnaka	Uppal ringroad(NB)	10,5	8055	7999	5252
	Habsiguda (SB)	12.5	10,100	9500	6563
	Lalapet (EB)	10	7600	7755	5250
	Osmania university	11	7769	8050	5775
Alkapuri	Nagole(NB)	14	7800	8050	7350
	L.B.Nagar(SB)	14	7000	5780	7350

**IV. CONCLUSION**

The undertaking plainly stress the necessity for estimation of PCU esteems upheld genuine field learns at the signalized crossing points for his or her examination and execution as these zone unit found to differ essentially when contrasted with IRC PCU esteems. Evaluated PCU worth's territory unit resolved to offer higher however reliable estimation of immersion stream for different approach widths when contrasted with IRC-PCU esteems. Measurable PCU esteems offer predictable worth of immersion stream per meter measurement of approach for all the methodologies. However measurable estimations of PCU neglect to explain the variety of immersed stream all through very surprising soaked unpracticed periods of flag. It attests that PCU esteems at signalized crossing points are to a great degree dynamic and more underscores the prerequisite of estimation of PCU esteems upheld very surprising extensive approach.

It's discovered that with expanding extent of bike, immersion stream per meter measurement also has a tendency to broaden in view of non consistency and filling of holes by bikes, while with increment in extent of autos the immersion stream tend to diminish as a result of a ton of homogeneity.



**V. REFERENCES**

1. Al-Ghamdi, Ali S, (1999).-Entering Headway for Through Movements at Urban Signalized Intersections.. In Transportation Research Record: Journal of the Transportation Research Board, No. 1678, TRB, National Research Council, Washington, DC, pp.42-47.
2. Abu-Rahmeh, F.W (1982).- Saturation flow and lost time at traffic signals. Ph.D. Thesis Department of Civil and Structural Engineering, University of Sheffield.
3. Al-Shu-bo and YANG Xiao-kuan (2009).- Capacity of Dual-Right-Turn Lanes at Signalized Intersections under Mixed Traffic Conditions..



- 4.AshworthR.(1976)-A Video —Taperecordingsystemfordatacollectionandanalysis., Traffic Engineering and Control, vol. 17.
5. Australian Road Research Board, (1968), -Australian Road Capacity Guide —ProvisionalIntroductionand Signalized intersection.,ARRB Bulletin No.4.
- 6.Branston,D., andVanZuylen, H. (1978). The estimationof saturationflow,effective greentimeandpassengercarequivalentsatrafficsignalsby multiplelinearregression. Transportation Research,Vol. 12(1), pp.47-53.
- 7.C.S.Anusha;AshishVerma,Aff.M.ASCE;andG.Kavitha(2013)-EffectsofTwo-Wheelers on Saturation Flow at SignalizedIntersections in DevelopingCountries’.
8. Cartagena,R.I. and Tarko,A.P.(2005) - Calibration of Capacity Parameters forSignalizedIntersections inIndiana., Journal ofTransportation Engineering, Vol. 131,No. 12, Dec2005.
- 9.Chandra,S.andKumar,U.(2003).-EffectofLaneWidthonCapacityUnderMixedTrafficConditions inIndia.,ASCE Journal of Transportation, 129(2), pp 155-160.
10. Chandra, S. and Sikdar, P.K. (2000), -Factors Affecting PCU in Mixed TrafficSituations in Urban Roads..

**AUTHOR DETAILS**

	p.pameswararao, pursuing M.Tech(Transportation Engineering) from Samskruti College of Engineering & Technology, kondapur Village, Ghatkesar, RangaReddy District, Telangana, INDIA.
	Kasireddy. Prathap Reddy, working as Assistant Professor from Samskruti college of Engineering & Technology, kondapur Village, Ghatkesar, RangaReddy District, Telangana, INDIA.