REINTRODUCING ROUNDABOUTS AS A JUNCTION CONTROL DEVICE IN THAILAND

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Abstract: The historical development of roundabouts and their benefits have been described .In recent times after the introduction of ' yield at entry' rule in England and France in 1966 and 1983 respectively, roundabouts have gained significant use and in many instances have replaced traffic signals. The analyses of 2 existing roundabouts in Thailand using aaSIDRA and field measurements show that they can perform adequately despite relatively high traffic volumes in peak hours. Comparison of an existing signal controlled 5 –arm intersection with a theoretical roundabout also indicates the superior performance of the roundabout. This paper describes the potential re-introduction of roundabout as a device for intersection control in Thailand. AaSIDRA was used as a tool to demonstrate the performance of roundabout and signalized intersections.

Key Words: Roundabout (s), Traffic Signal, Delay, Capacity, Safety, Intersection Control

1. INTRODUCTION

Roundabouts have been used as a traffic control device in Thailand since the 1940's. However, during the past three decades, most have been gradually replaced by traffic signals. This is due to both the misunderstanding that traffic signal is more superior than the roundabout and in the case of Bangkok ,the severe traffic congestion which renders any form of traffic control device inadequate. This paper describes the world wide trend in the use of roundabouts and how roundabouts can be used as an effective junction control device in Thailand.

1.1 World Wide Application

De Aragao(1992) wrote that the first roundabout was installed in France on 1877 by Eugene Henard (French architect). At the same time, William Eno, the American architect made use of a mini-roundabout as a traffic control device in New York City. After the rule of "yield-at-entry" which were developed in England and France in 1966 and 1983 respectively, the use of roundabouts has become more widespread.

Bovy (1992) reported that the number of roundabouts in the Netherlands that have been installed during 1981 – 1990 has increased greatly to about 400. The main reasons are their ability to reduce the severity of accidents, in reducing speed, and relative low costs of maintenance.

Giaever (1992) reported the astronomical increase of the number of roundabouts in Norway from 15 in 1980 to 350 in 1990 and 500 in 1992.

Use of Roundabouts in the United States of America has not developed much further since the time when William Eno introduced roundabouts in New York City until recently. Presently, American highway engineers are showing increasing interest in the use of modern roundabouts to reduce accidents and increase capacity.

The use of roundabouts in Australia is quite popular, large number of previously priority-controlled junctions have been replaced by roundabouts. In newly developed suburbs roundabouts are widely use as junction control device.

The major benefits of roundabouts are their better safety records over that of traffic signals and their higher capacity relative to signalized intersections particularly those with 4-phase controlled (Brilon (1993)).

1.2 Safety Performance of Roundabouts

Experiences in many countries show a significant reduction in crashes and injuries when roundabouts were used as traffic control device. Table 1 shows some of these results.

Table 1. Mean Crash Reductions in Various Countries.

Countries	Mean Reduction (%)	
	All Crashes	Injury Crashes
Australia	41-61%	45-87%
France		57-78%
Germany	36%	
Netherlands	47%	
United Kingdom		25-39%
United States	37%	51%

Source: Garder, P. (1998) and Guichet, B. (1997)

It is seen that up to 87% of injury crashes can be reduced by installation of roundabouts. In addition, small roundabouts can be effectively used as traffic calming device in residential areas as indicated by experienced in Australia, the United Kingdom and other European countries.

2. USE OF TRAFFIC CONTROL DEVICES AT JUNCTIONS IN THAILAND

Most of the highways in Thailand, have been designed by the Department of Highways . Roundabouts, stop signs and traffic signals have been used as traffic control devices at intersections. 'Yield' or 'Give Way' signs are use for merging lanes only.

Since the 1940s, many roundabouts have been built in Bangkok such as the Victory Monument Roundabout, the Democracy Monument Roundabout, the "July, 22 nd" Roundabout, and the 'Big roundabout'. The use of roundabouts have spread to the provinces. In the early day, all of them not only used as a traffic control device but also as monuments, clock towers, and so on.

For some roundabouts, the area of the central island is large so as to accommodate monuments. They functioned efficiently as a traffic control device at that time as traffic volumes was moderate and below well below capacities. At present, some of them have been replaced by traffic signals, both in Bangkok and the provinces. Most of the roundabouts in Bangkok experienced the problem of severe traffic congestion. The roundabouts with monuments were modified by installation of the traffic signals , one in the northern part of Bangkok was converted to grade separated intersection.

In the provinces, most of them still work quite well. A few were replaced by traffic signals in the belief that they would improve traffic flow, only to regret that it was not so.

Generally, most of them are the old style roundabouts. The inscribed diameter is usually large and the same sizes (30-60 m.). Most have no splitter islands, no deflection entry, no signs and markings.

Presently, roundabouts do not get the attention they deserve as an efficient junction control device in Thailand . Little knowledge on the design and construction are available to engineers, thus add to its limited application.

3. CAPACITY AND PERFORMANCE

This research investigates the traffic performances of the Nam-Poo Roundabout in Hat Yai and the Yala Hospital Roundabout. Both of them are 4-arm roundabout and locate in the urban area of the cities. The size of the roundabouts are quite similar but the traffic volumes and performance are different. Traffic at the Nam-Poo Roundabout is rather congested during peak hours but traffic at the Yala Hospital Roundabout flows well.

The traffic volume data were collected for 2 hours period in the morning peak, off peak and the evening peak on 2 weekdays. The delay and queue length were measured by using stopped vehicle method. The traffic data were used in the aaSIDRA program (Akcelik & Associates (2000)) to analyze the performance and compare with measured performance. The performance of the 2 roundabouts were presented as delay, queue length, and level of service. In the analyses, the following
values were used: saturation flow 1950 tcu/hr (through car unit), peak hour factor 95%, approach distance 1000 m., and approach and exiting speed 60 km/hr.
These are mostly default values, for the purpose of comparision between signalized junction and roundabout, the same set of values were used.

3.1 Nam-Poo Roundabout

Nam-Poo Roundabout is located in the central of Hat Yai city. The junction of Petchkasem Road, Niphatsongkhor Road and Pratan-Utit Road. It carries moderate flows of traffic through out the day. The central island diameter is 20 m. and the inscribed circle diameter is 44 m. It has 3 lanes circulating carriage way and 12 m. circulating carriage way width. The total flow at the roundabout was 4,204 veh/hr.

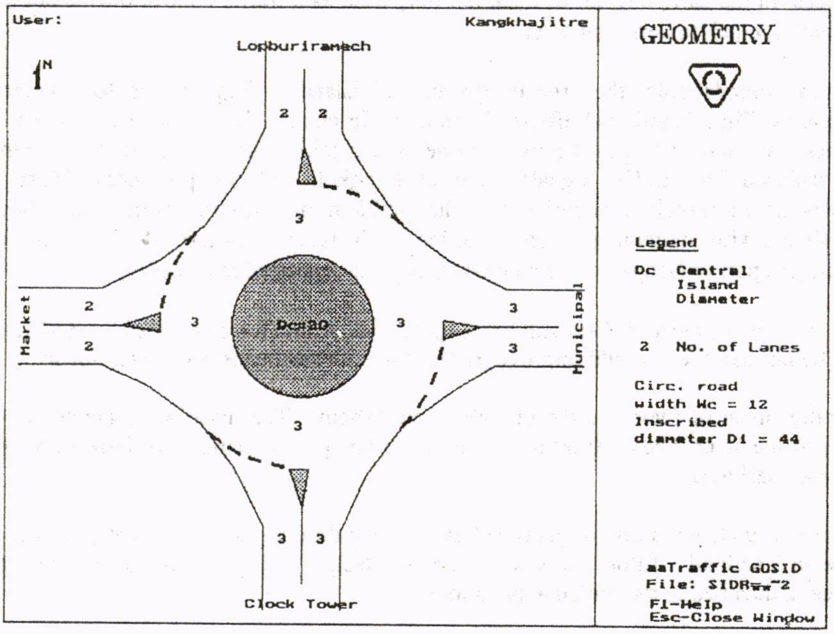

Figure1. The Geometric Layout of Nam-Poo Roundabout From aaSIDRA

Each arm has a splitter island but the shape of the island does not form the deflection at entry which forces drivers to reduce speed. The aaSIDRA was used to analyse the performance of the roundabout in terms of capacity, level of services, average delay and queue length.

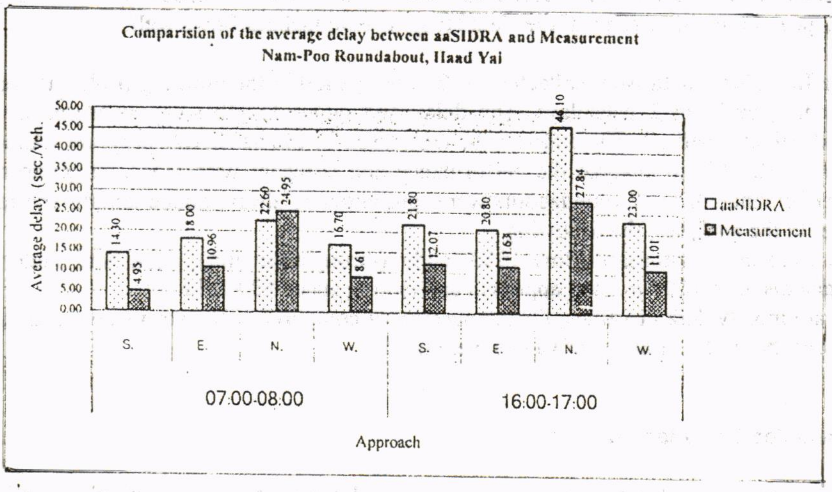

Figure 2. Comparison the Average Delay of aaSIDRA with the Site Measurement at the Hat Yai Roundabout

From the figure , most of the average delay values from aaSIDRA are higher than the measurements except the north approach arm (Lopburiramech) on morning peak that is a little bit lower. The average delay values of the north approach arm on evening peak from aaSIDRA is quite high and level of service is "E". Even though the absolute values are quite different but the trend quite similar in that the measured values are consistently less than those from aaSIDRA output. There is North approach arm has the highest average delay and the remainder are similar. The level of service is between "B" and"C".

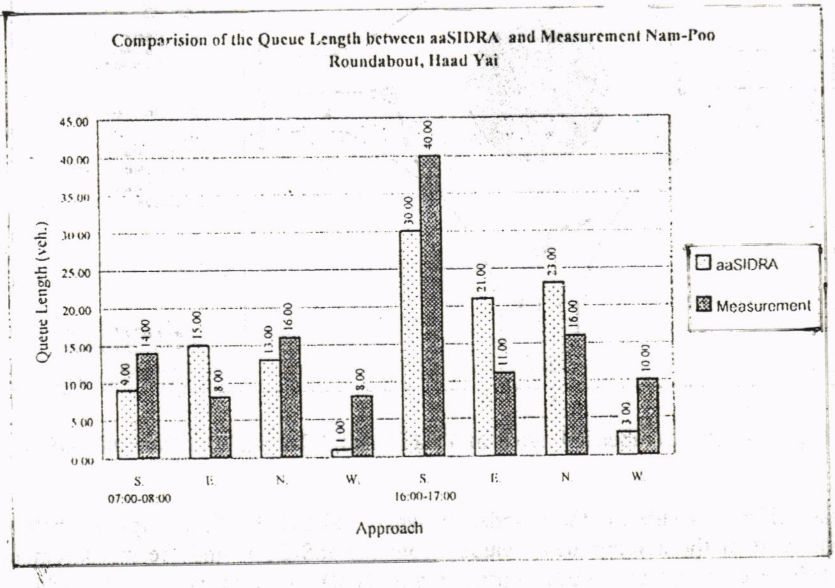

Figure 3. Comparison the Queue Length of aaSIDRA with the Measurement in the Site of Hat Yai.

From the figure , the highest queue length by measurement is from south approach arm (Clock Tower) in both peaks and by using aaSIDRA is from east approach arm (Hat Yai Municipality) in the morning peak and from north approach arm (Lopburiramech) in the evening peak. It is clear from the comparison that there is a need to calibrated aaSIDRA to reflect the local traffic situation before it can be used to properly analyze the roundabout.

3.2 Yala Hospital Roundabout, Yala

Yala Hospital Roundabout is located at the edge of urban area of Yala city at the junction of Petchkasem and Siroroj Road. It carries a moderate flows during peak hours. The central island diameter is 20 m. and the inscribed circle diameter is 40 m. It is a 2 lane circulating carriageway with 10 m. width.

Only 3 arms have splitter islands but the shape of the islands do not have deflection at entry to force drivers to reduce speed.

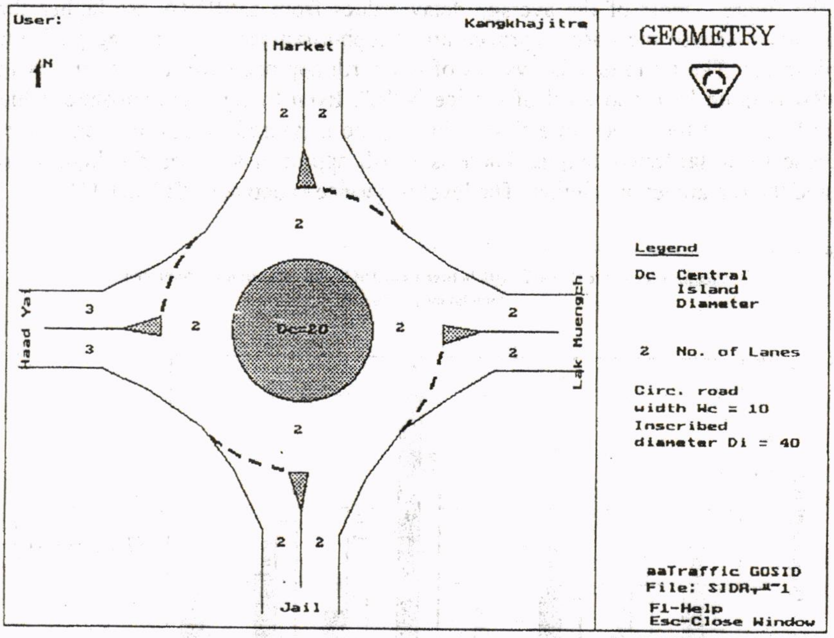

Figure 4. The Geometric Layout of Yala Hospital Roundabout from aaSIDRA

The total traffic flow entering the roundabout was 1,967 veh./hr. From Figure 5 below, it is seen that most of the average delay values from the aaSIDRA and the measurements are comparable except for the south approach arm (Jail) on both peak hours where the measured values are significantly higher than those from aaSIDRA. The average delay values of the west approach arm (to HatYai) for both peaks from the aaSIDRA and the measurement also differ substantially. This indicates a need for proper calibration of the model. The average level of service is "B".

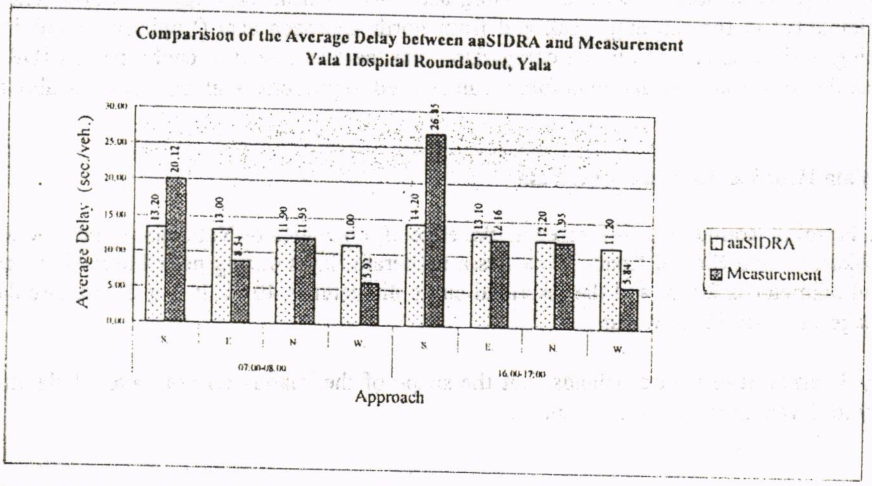

Figure 5. Comparison the Average Delay from aaSIDRA with the Measurements at the Yala Site

Table 2 shows the comparison of delay and queue length for 3 different situations: the existing intersection, the existing intersection with traffic signal adjusted for optimal performance and the theoretical roundabout.

Table 2. Comparison of Queue length and Delay of the 5-Arm Intersection in Yala.

Approach	Existing 5-Arm Intersection		Traffic Signal Adjusted		Roundabout	
	Delay (sec./veh.)	Max. Queue (veh.)	Delay (sec./veh.)	Max. Queue (veh.)	Delay (sec./veh.)	Max. Queue (veh.)
A1	39.10	7.00	22.60	8.70	13.00	1.50
A2	15.30	8.00	27.60	7.30	15.00	1.50
A3	30.60	5.00	19.80	10.70	12.70	3.00
A4	32.00	7.00	28.90	4.10	15.90	1.10
A5	31.60	5.00	25.20	3.20	15.60	0.70

From the table, it can be seen that there are significant improvements for all approaches in terms of delay and queue length for the roundabout. With the adjusted signal timing, the cycle time was reduced from 93 seconds to 60 seconds the overall
Performance of the signal was also improved. For example, the roundabout has reduced the delay from the A5 approach to less than 16 seconds from some 25 seconds in the case of adjusted timing. The maximum queues are also significantly decreased over those computed for the adjusted signal timing,eg. from 10.7 vehicles to 3.0 for A3 approach.

Table 3 shows comparison of intersection performance for the 3 situations, it is seen that the level of service for the case of roundabout has improved to 'B' while the average intersection delay has decreased from 24 to 14.

Table 3. Comparison of Intersection Performance for Pang-Mueng 4 Intersection, Yala

Intersection Parameters	Existing	Traffic Signal Adjusted	Roundabout
Intersection Level of Service	C	C	B
Worst Movement Level of Service	D	C	C
Average Intersection Delay (sec.)	33.3	23.5	13.8
Largest Average Movement Delay (sec.)	42.2	31.1	20.3
Largest Back of Queue, 95% (m.)	96	66	19
Performance Index	64.12	51.77	34.7
Degree of Saturation (highest)	0.754	0.630	0.366
Practical Spare Capacity (lowest)	19%	43%	132%

4. COMPARISON OF PERFORMANCE OF ROUNDABOUT AND TRAFFIC SIGNAL

Case Study: Pang-Mueng 4 Intersection, Yala

Pang-Mueng 4 Intersection is the 5-arm signalized intersection with 3 phases and 93 seconds cycle time . Traffic flow ,delay and queue length data for peak periods were collected for analyses to determine its existing performance and its improved performance by modification of existing timing of the signal, this was carried out by selecting the optimal cycle time which minimizes delay and to compare with a theoretical roundabout which the Yala city desires to put in place to replace the signal which creates unnecessary delays particularly during off peak hours.

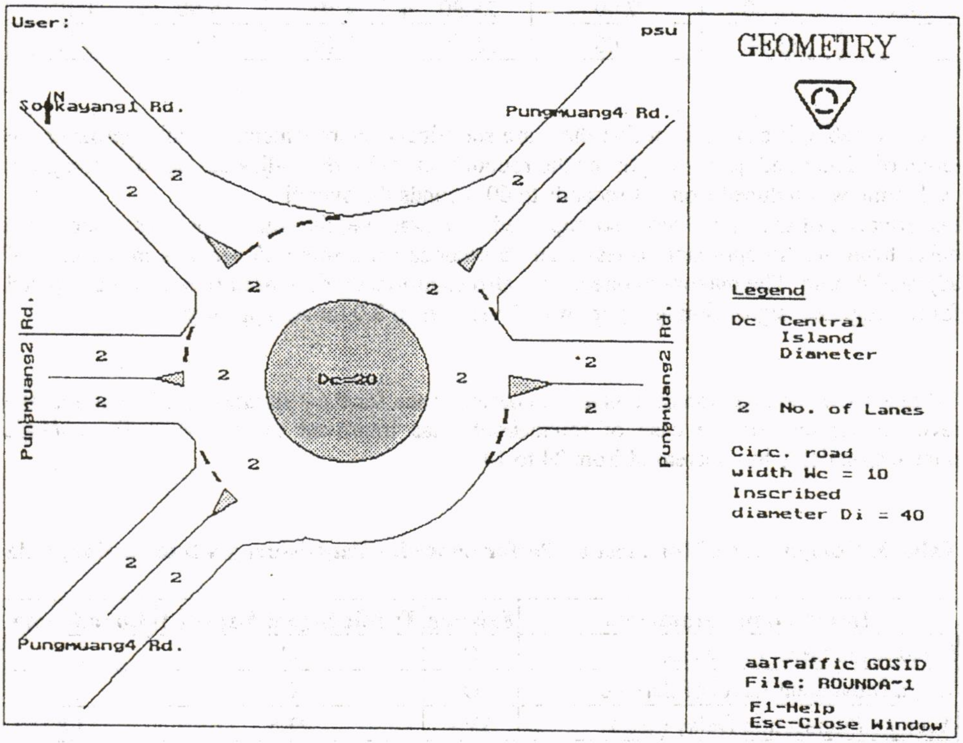

Figure 6. The Geometric Layout of a theoretical Pang-Mueng 4 Roundabout

5. CONCLUSIONS

The paper describes international and Thailand experiences in the use of roundabouts. The safety performance of roundabout compared to signalized or priority junctions are well known and is also illustrated in the paper. The performance of two roundabouts were described . A case study comparing the performance of a theoretical roundabout with that of the existing traffic signal show a significant improvements in terms of delay , queue length and level of service.

aaSIDRA was used as the tool for analyses and making comparison, the results indicate that to properly use the program , there is a need to calibrate it to reflect local traffic situation. However, based on relative values of performance indicators, it is clear that roundabout performs better than the 5-arm signalized intersection.

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